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for the drilling-producing-pipe line industry

PETROLEUM REFINER and The **REFINERY CATALOG**
for the refining-natural gasoline industry

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250 Park Ave.
New York 17, N. Y.

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W. W. Wilson Bldg.
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ANTHONY GIBBON
Hunt Bldg.
Tulsa 3, Okla.

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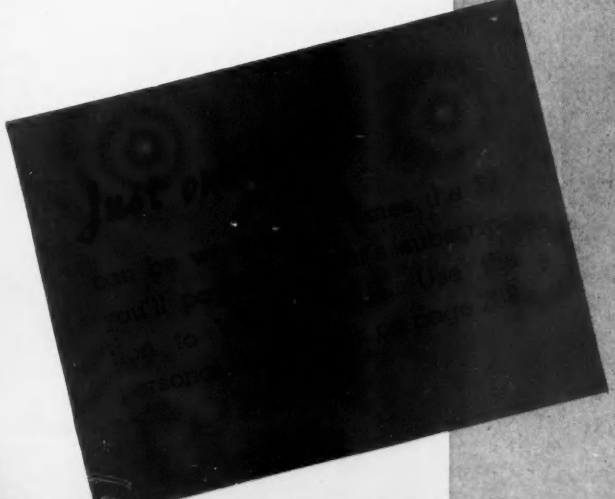

WORLD OIL

Established 1916 as THE OIL WEEKLY

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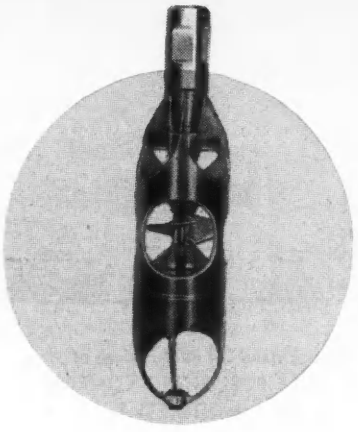

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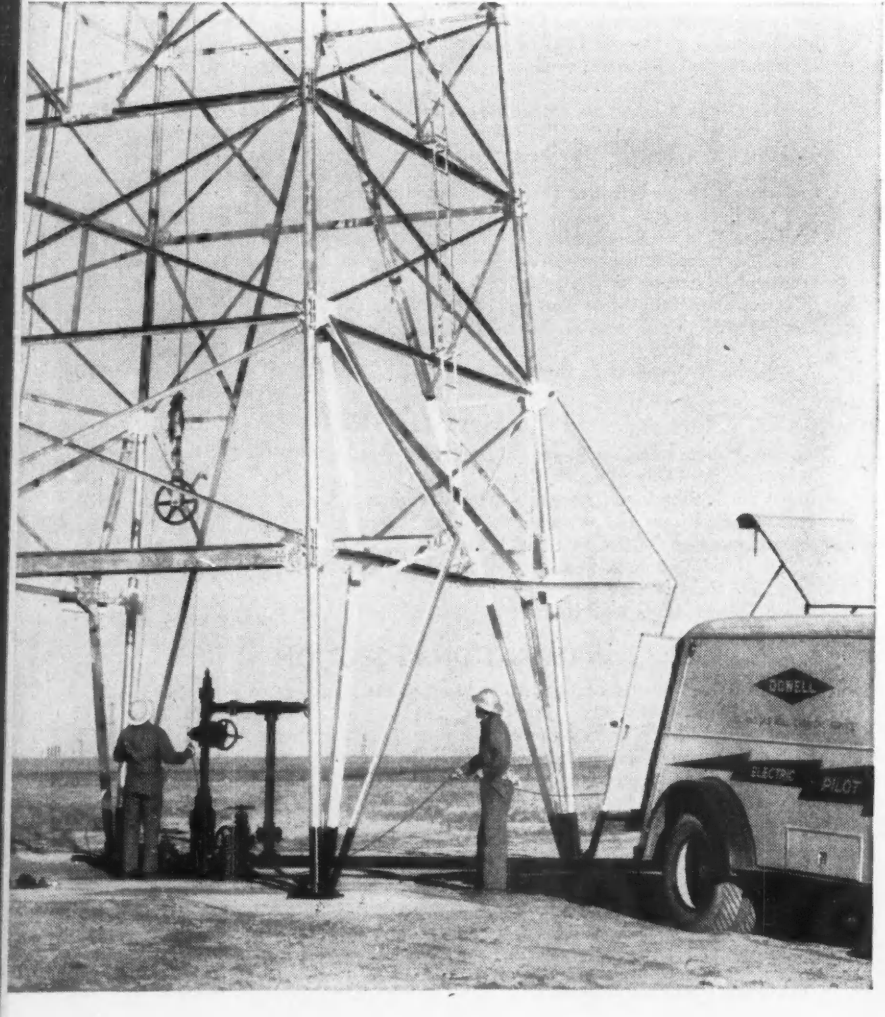

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MASK OR BLINDFOLD?

WE HAVE been reading lately that the "mask is off totalitarian Russia." But let's be fair. The mask is not off totalitarian Russia—the blindfold has merely slipped from the eyes of some of the people of the rest of the world.

Russia has never been, at any time within two-score years, more than she is today. With all their talk of "democracy" in which they indulged in 1945 and 1946 the powers that rule Russia with an iron hand have never relaxed for one moment the deathlike grip they have maintained upon their own people and the peoples of areas unfortunate enough to be within their power. They have never truly sought to help create a world in which all of us might live in peace. From the very beginning of the United Nations, that sad experiment in idealism in a world of realism, they have shown an inability to grasp the idea that peoples with divergent thoughts on personal liberty can live in peace on the Earth.

From the beginning they have mistaken (as is almost always the case) appeasement for cowardice. Never have they relented for one moment in their preachment that the western powers, including the U. S., were decadent . . . ready victims to vigorous Communistic thinking and action. Never have they shown the least appreciation of why the people of the U. S. twice went to war against Germany, but Nazi-like have thought that ruthlessness would win for them whatever their objectives might be.

No, in all fairness, Russia has not worn a mask. She has consistently proved to the world that the only difference between Naziism and Communism is that a hierarchy in Germany conceived and executed the one and that a similar hierarchy in Russia has conceived and is executing the other. As has been said a thousand times, the roads of the two ideologies lead to the same goal . . . personal power of an unlimited nature for the rulers and abject misery for those who are ruled.

But the time is rapidly shaping up when repetition of the words spoken a thousand times will not be enough.

Are we to forget what happened to the scrap steel we sent to Japan? Have we forgotten the American deaths made possible by the gasoline sent to the Japanese?

Russia today is feverishly building up her manufacturing power. There seems little hope that we shall not have to meet head-on that power before too long a time has passed. Why then allow a flow of American goods to continue to Russia and her satellites? Specifically, why continue to send oil country equipment to Russia? Oil, we all know, is vital to the successful prosecution of any war, be it of aggression or defense. Why help an enemy build up her oil production and supply?

If any manufacturer would think first of his business, let him think also of his sons, his grandsons, his nephews, the sons and loved ones of his friends, and let him think of his wife, his daughter and his granddaughters and the daughters of his friends, because the next war will be brought to our own shores as surely as the sun will rise.

Now that the blindfold has slipped from the eyes of some who believed against reason, that Communism really meant brotherly love, who felt that appeasement was the proper policy, let us recognize those who still hold to a policy of appeasement for what they really are: fools or worse.

That recognition should be only a part of our self-defense. More is needed. A realistic appreciation for what is ahead should dictate a lot of things which ordinarily are repugnant to us. Few Americans of two generations ago would have favored universal military training, because there was no horde with which to deal. The example of German militarism under the Kaiser was so distasteful to the American way of thinking that we forgot the difference between defense and offense. But we should know better now. The blood of thousands of American boys, already sacrificed because the enemy thought we were not prepared and consequently ignored the price of aggression, is enough sacrifice to have paid.

Let us not forget the chaotic times of 1942 and late 1941 when we were almost defenseless, and the plans for the manufacture of the necessities of war about which we had heard so much (remember what was to have been M Day) turned out to have been so many mouthings by inept politicians.

Let us not forget all of those things. Let us seek no war, but be ready to resist with all of the might within our being, any war thrust upon us.

Ray L. Dudley

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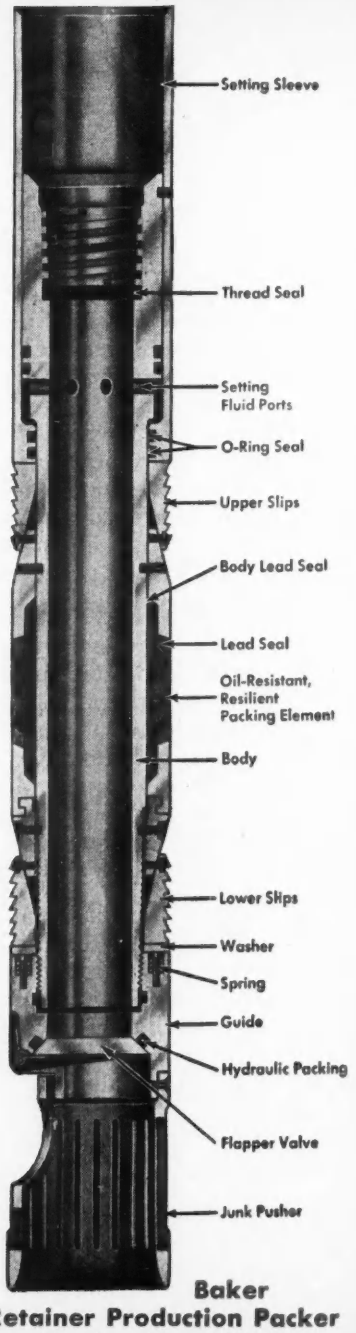

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The Changing Panorama

Next Problem: Expansion Funds

PLANS FOR enormous world-wide expansion of oil industry facilities have brought question as to possible difficulty in raising the vast amounts of capital to be required. Normally, the industry largely finances its necessary expansion, as petroleum demand increases, by plowing back a comparatively large percentage of its earnings, meanwhile paying generally conservative dividends to stockholders. Only in limited degree does it resort to the two other sources of capital; issuing new stock and borrowing.

In the present situation, with expansion needs so great, there is fear that oil industry earnings might not be sufficient to permit the usual amount of capital expenditures from earnings after paying even the customary conservative dividends. Insofar as earnings should fail to cover expansion needs to a normal extent, new stock issues and borrowing would have to be above normal, thus weakening the market for oil stocks and tending to raise interest rates on money borrowed by the industry.

In view of this extraordinary need for capital with which to expand the industry, the current relatively high reported earnings of the industry are very essential, greatly helping the industry to finance the urgently needed new facilities. Making favorable earnings doubly necessary are the greatly inflated costs of all new plants, wells, and other properties. While more new facilities than usual are necessary, they also cost much more per unit than formerly. Thus higher earnings are needed for procuring them, and the higher earnings in turn are possible only with benefit of better prices than formerly for crude oil and petroleum products.

Fortunately, prices and earnings of the industry are favorable, and in some authoritative quarters it is expected that the oil industry will be able to meet its capital requirements at least in 1948 largely out of its own earnings. In a paper at the recent annual meeting of the AIME at New York, Dr. Joseph E. Pogue and Frederick G. Coqueron of the Chase National Bank expressed the opinion that the oil industry will require less outside financing in 1948 than it did in 1947, despite costly expansion.

Curbing Europe's Conversion to Oil

IN CONGRESS there is a discounting of the urgency of Europe's oil requirements and a frowning upon threatened over-conversion from coal to oil in the European countries. The plans for U. S. aid to European recovery are being examined closely for possibly seriously damaging effect on the tight oil supply situation of the world as well as the U. S.

The Senate foreign relations committee, accordingly, has inserted provisions in aid-to-Europe legislation that are intended to hold within reasonable bounds the projected European conversion from coal to oil.

Senator Lodge, Republican, Mass., has offered an amendment that would require the aid administrator, in authorizing the furnishing of commodities to Europe, "to take fully into account the present and anticipated shortages of petroleum and the consequent undesirability of expansion in petroleum consuming equipment where use of alternate fuels or other sources of power is practicable."

Also added into the measure by the committee at Lodge's request is a requirement that oil for Europe be supplied from sources outside the U. S. to the greatest extent practicable.

This viewpoint is in line with the U. S. government's recent tightening up on all oil exports to save supplies urgently needed for domestic use. Scrutiny of European coal-to-oil conversion also is justified by the fact that the U. S. may have to discourage within its own borders the increased use of oil in lieu of coal in order to assure ample oil for purposes where coal cannot be substituted, as in aviation, automotive, and military usage.

". . . . No person is capable of rising above his best judgment. To live in strict accordance with it is to live as good as one can, or as mean as may be. Hope for personal betterment lies in raising the level of one's judgment; judgment is a limiting factor."
LEONARD E. REED

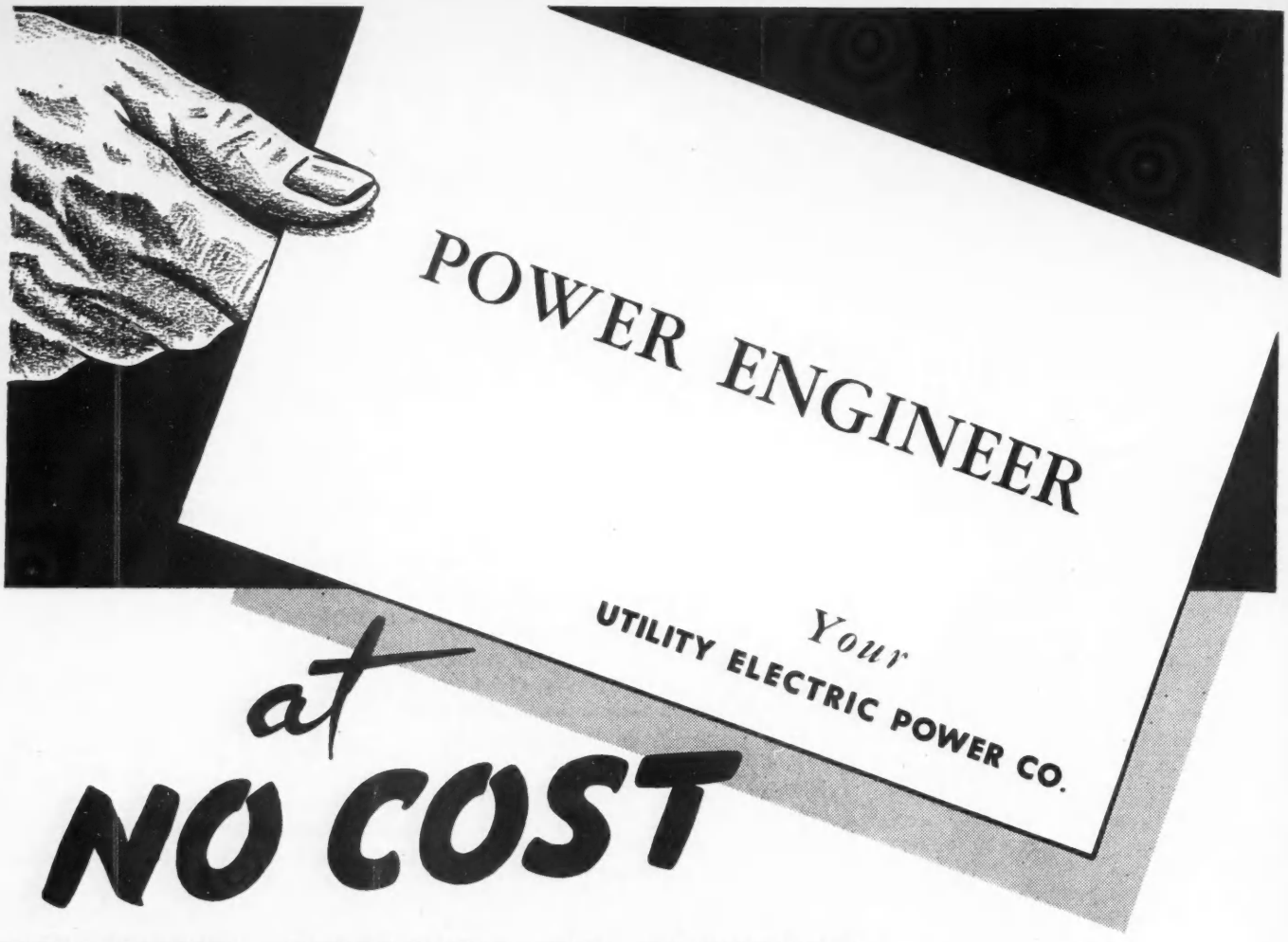
Gulf Exploration Programs Pushed

IMPORTANT production of petroleum along the Gulf Coast within the next several years is promised, if tidelands oil development is not retarded or stopped by assertion of federal government claims to those lands and subsequent adverse federal restrictions upon them. Heretofore, development has proceeded quite satisfactorily under leases granted by such states as Louisiana, Texas, and California.

In keeping with the oil industry's all-out effort to increase petroleum supply to meet heavy postwar demand, several companies have plans for vigorously pushing actual drilling programs on the Louisiana-Texas tidelands, although costs will be comparatively great.

J. L. Latimer, president of Magnolia Petroleum Company, announced plans February 29 to drill six additional wildcats off the coast of Louisiana. In that area the company has spent over $9 million for lease bonuses, lease rentals, seismograph exploration, and drilling operations. One deep well and one shallow well have been completed, both dry. The third well is now drilling below 12,600 feet. Although oil or gas have not yet been discovered in the area, Magnolia plans to drill six more wildcats in the Gulf as part of its intensive effort to find new reserves.

Humble Oil & Refining Company is among several other concerns also planning to drill in the Gulf. In an effort to keep pace with increasing demand, stated H. C. Wiess, president, Humble will carry out in 1948 the most expensive program of drilling in its history; and as a part of the program, it will drill three or four wells in the Gulf. "Drilling on these submerged lands is difficult and costly," stated Wiess, "but the high level of demand makes it mandatory that this area on the continental shelf be developed promptly."



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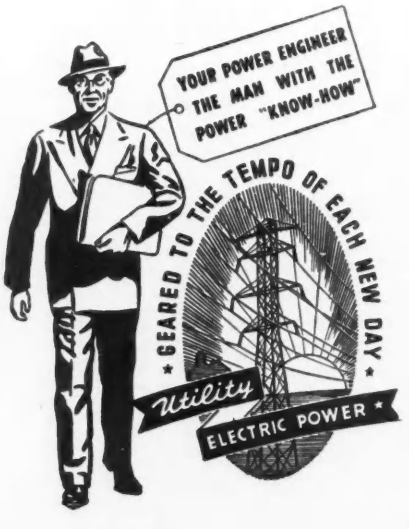

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MONTHLY NEWS ANALYSIS

**CONTROL BILL THREATENS . . . NEW ROUND OF PAY HIKES BEGINS
HIGHER PRICES DEFENDED EMERGENCY STOCKS NEED APPARENT
DESIRABILITY OF BURNING LESS OIL IN FURNACES IS STRESSED**

Oil Control Bill to Be Held Over Industry as Threat

Although it is conceded virtually no chance of either passage or Presidential signature, the oil control bill introduced in the House by Rep. Heselton, Republican, Mass., impresses vividly upon the industry the urgent necessity of increasing oil supply and of holding prices down. (The bill, H. R. 5392, would create a National Petroleum Commission for regulating and controlling the petroleum industry, with powers similar to those exercised by the Interstate Commerce Commission.)

Even the author of the bill said: "If the industry meets the challenge of providing supplies at reasonable prices, I say leave them alone. But if they don't, there is my bill to confront them."

The bill will be left "in the hopper from now on, as a reminder," he said. "If there is another raise in prices, there will be added consideration for the measure."

This bill was introduced in response to protests from the Massachusetts congressman's constituents over shortage of fuel oils for heating homes and for industrial use.

The best defense the industry can put up against such protests of the public and such action in Congress is to do its utmost toward making supply ample and holding prices down.

For those who know and understand the petroleum industry there can be no doubt whatever that it will successfully "meet the challenge of providing supplies at reasonable prices." It will do as much drilling, pipe line building, tanker construction, refinery expansion, and oil importing as the nation's requirements call for and it will do so with characteristic vigor and dispatch, going ahead as fast as supplies of steel and other scarce materials permit.

Nevertheless, as a member of Congress advised oil industry spokesmen at a hearing before a congressional committee, the industry should widely publicize its efforts toward wiping out shortages and fully explain current relatively high oil prices. The public must be informed on the industry's problems if it is to understand them, and it must be shown that effective remedial action is being taken if it is to refrain from complaining.

Oil Workers' Wage Demands May Develop Into Boomerang

The third round of wage increases has begun in the U. S. and the oil industry faces demands for wage hikes, although already complaining of excessive costs and the pressure of those costs on oil prices. Some larger corporations in various industries have announced wage increases for the third time since V-E Day, this time mostly from 8 to 15 cents an hour. Important union contracts in various industries will soon be up for renewal. In the oil industry a wage increase of 30 cents an hour has been officially demanded.

Under strong public and political pressure for greater production and lower prices, many companies doubtless will lean over backward to avoid strikes, agreeing to moderate wage increases in the hope that labor tranquility, efficiency, and increased production will justify higher wages and obviate the necessity of charging higher prices.

Oil companies have conisistently paid workers higher than average wages and may be expected to continue paying employes better than most other industries if they remain able to do so by virtue of adequate prices and earnings. The ability to pay workers favorably is due mainly to the industry's exceptionally heavy investment in tools and facilities behind each employe. The ability to provide these facilities depends, in turn, upon favorable earnings and resultant funds with which to procure the facilities for aiding the employe in his work. The oil industry worker should be the last to criticize oil company earnings, which buy his tools and thereby increase the effectiveness and value of his work.

However, the National Policy Committee of the Oil Workers' International Union, affiliated with the CIO, in voting recently to demand an hourly wage increase of 30 cents, condemned oil price increases and oil company earnings. The union's public statement on the subject said: "We are asking a substantial wage increase from the oil industry, which has pillaged the public by one price increase after another, although their profits already soar above any record ever made. The wage advance can easily be granted from a thin slice of the oil industry's profits without the slightest increase in the price of gasoline or fuel oil. Profits for the first nine months of 1947 were 83 percent above those for 1946. Since the ending of OPA crude oil prices have advanced nearly 100 percent. The increase in the price of refinery products alone is seven times greater than the entire daily wage of hourly paid workers in the refineries. Because of increased productivity and other factors, petroleum refining has experienced a 29 percent drop in labor costs in relation to the value of products.

"In the event prices continue to increase, we intend to adjust our demands upward to meet the needs of our members' families."

From the sidelines, it looks as if moderate wage increases may be acceptable to oil companies but as if the union is overplaying its hand in charging the industry with "pillaging the public." Such charges could backfire by causing damaging government restrictions on the industry, impairment of oil company earning power, and narrowing of wage-paying ability.

Sun Oil Company President Defends Higher Crude Prices

Higher prices for oils were defended by Robert G. Dunlop, president of Sun Oil Company, before the House Interstate and Foreign Commerce Committee at Washington February 17. Higher crude prices have resulted in significant increases in production, he declared, and a price freeze or price rollback would "require producers to delay or abandon plans for expanded operations at the present greatly increased costs."

Dunlop described price as "the regulator and the governor" of production in a competitive system, and said crude oil

NAVY OIL FOR NEW YORK CITY—The Navy Tanker "Mission San Luis Obispo" arrives at Port Socony, Tottenville, Staten Island, with much-needed fuel oil. The Navy is lending part of its reserve stock to New York state to relieve the critical shortage. New York City gets 2,700,000 of the 4,200,000 gallons on this vessel.

—Acme Photo.

production in the most recent four-weeks' period was more than 500,000 barrels per day above production in the comparable period prior to the first price increase in 1947.

Increased production remains the only completely satisfactory answer to the problem of balancing supply of oils with demand, declared Dunlop, and increased price proves an incentive for stimulating increased production. This is borne out by the historical fact that the trend of well drilling follows the pattern of crude prices. New oil discoveries as well as increased production are dependent on well drilling. He presented a graph illustrating over a period of years the marked relationship between crude prices and well-drilling activity.

The fact that increased price means increased production is clearly demonstrated, he continued, by what has happened during the past year. During 1947 crude prices advanced three times: March 10, October 18, and November 28. During the four weeks prior to the March 10, 1947, increase in prices U. S. production averaged 4,784,750 barrels daily, according to API figures. During the four weeks prior to the October 18, 1947, increase, production averaged 5,229,300 barrels daily. In the four weeks prior to November 29, 1947, production averaged 5,257,300 barrels daily. In the past four weeks, ended February 7, 1948, production has averaged 5,328,300 barrels daily. In other words, he summarized, daily average production in the last four weeks for which figures are available was 543,550 barrels greater than in the four weeks before the March 10, 1947, advance; 99,000 barrels greater than in the similar period preceding the October 18, 1947, advance, and 71,000 barrels greater than in the four weeks prior to the November 28, 1947, increase.

"These daily average increments become sizable volumes of oil when multiplied by weeks and months," Dunlop said. "Without doubt the current situation would be much worse than if the industry had not produced these additional quantities of crude. I know of no reason for this constant increase in production other than the incentive of higher prices.

"There has not been time for the development of the full effect of the November 28, 1947, price advance on increased supply," he added, "especially because of the scarcity of tubular goods available to the industry. But I have no doubt that production will continue to rise, unless current proposals for price freezing—and even worse, price rollbacks—require producers to delay or abandon plans for expanded operations at the present greatly increased costs."

Refining and Transportation Cost Hikes Burden Industry

Besides the greatly increased costs that the petroleum industry encounters in all drilling and production operations and when it contracts for any kind of repair or construction job, in the maintenance, improvement, and expansion of its facilities, there are greatly increased costs in refining, transportation, and distribution. Higher railroad freight rates are but a small part of these added costs.

Esso Standard Oil Company (formerly Standard Oil Company of New Jersey) recently stated that it had increased production of heating oils 35 percent to help meet the shortage precipitated by abnormally cold weather, having adjusted refinery yields to maximize the production of that critical product, principally at the expense of gasoline that would have brought higher prices.

The same company said it also was using all other possible means of increasing its heating oil output, including some measures that are out of the ordinary and exceptionally costly. To squeeze every possible drop of heating oil out of the crude, it had put into use equipment which under ordinary circumstances would be regarded as obsolete. In all its refineries the company was turning out maximum amounts of kerosine and heating oil at the expense of higher value products.

Although under normal conditions practically all crude moves to refineries by tankers and pipe lines, the company has been supplementing these forms of transportation by hauling crude from West Texas and other fields by railroad tank cars at an added cost of 1¼ cents per gallon. This cost has been absorbed and not passed on to the consumer.

To augment the supply of finished heating oil in the Northeastern states, the company has also used railroad tank cars to bring this product all the way from Baton Rouge, La. The cost of these tank car movements is six times the normal cost of shipping by tanker, but this emergency method has added materially to the East Coast supply, with the company here again absorbing the higher cost. This company's efforts are typical of those being put forth by virtually all companies in trying to meet the needs of the consumers.

Improved Prices Necessary In Midwest, Committee Told

Improved prices continue necessary in alleviating the scarcity of oils in the Middle West, it was stated by W. W. Vandeveer, president of Allied Oil Company, Cleveland, before the committee on interstate and foreign commerce of the House of Representatives at Washington, February 18.

Because of a dislocation in domestic crude supply, he said, it has been necessary to resort to unusual and expensive methods to keep refineries running. Independent Midwest refiners formerly obtained most of their crude right in their own back yard. But today, crude production in the 15 Midwest states is down ¼ million barrels a day from 1941. "The Midwest refiner has had to find the crude wherever he can, and haul it to his refinery by any and all possible means, regardless of cost. This has been necessary to deliver adequate supplies to the consumer.

"Rolling back prices now," declared

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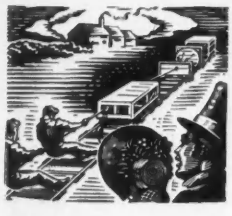

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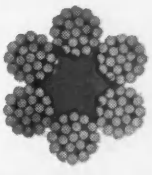

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A CENTURY OF CONFIDENCE

Vandeveer, "would make it impossible for the independent oil company to pay for these extraordinary steps he is taking to bring oil from where it is to where it is needed—and would force him out of business."

Commenting further on costs and prices, he stated that the industry has to pay more to discover oil, to drill wells, and to refine and distribute oil products. It costs more to replace or expand existing plants to meet essential needs. These higher costs are reflected in prices.

Vandeveer's testimony gave no support to any charges of unfair practices within the petroleum industry. He said that his company has received the highest degree of cooperation of the companies from which it buys crude and finished products. This cooperation has helped, he said, to assure the delivery of essential fuel oils for homes and industry."

Scarcity of Oil Encourages U. S. Water Power Projects

An unexpected result of the current oil scarcity is a perceptible encouragement of federal water power projects. Henceforth, the supporters of such projects can use effectively for furthering their plans the fact that oil has been scarce.

In line with this subject, the Bureau of Reclamation has announced new schedules for building hydroelectric facilities on Western irrigation projects, forecasting that by 1953 enough new electric power will be made available to equal 30 to 40 million barrels of oil a year.

It is pointed out that the revised projects will ease the need for such a critically short fuel as petroleum, besides advancing Western river basin development bringing 4 million new acres under irrigation.

The thought was expressed by government representatives that by harnessing the power now wasting down Western rivers, petroleum can be released from some present uses for use where there is no satisfactory substitute, as for aircraft, automotive, military, and naval usage.

It should be pointed out that while it may appear impressive to speak of 30 to 40 million barrels of oil per year saved by hydroelectric power, such amount is relatively small compared with present oil consumption. Annual consumption now is around 2 billion barrels—50 times 40 million barrels. Oil in the annual amount of 30 million barrels is equivalent to 82,000 barrels daily, and the annual amount of 40 million barrels is 110,000 daily. These amounts are equivalent to the output of eight or ten good but not unusual 10,000 barrels a day U. S. oil fields.

Need for Emergency Stocks Emphasized by Cold Weather

The importance of emergency stocks of oils in addition to comfortable working stocks has been emphasized by this winter's siege of abnormally cold weather, with virtually the whole U. S. experiencing temperatures consistently many degrees below normal. Some fairly serious scarcities of heating oils have been precipitated by the frigid weather, heaped on top of an already tight oil supply situation.

Prior to the war, inventories of oils were a matter of importance only from the standpoint of being constantly on guard against allowing them to become burdensome and market-wrecking. On the rare occasions when stocks of crude or particular products appeared relatively light, there was speculation and disagreement but no conclusive evidence as to just what amounts of inventories represented the minimum essential working stocks.

However, some of the mystery about minimum working stocks was solved during the war when many tanks were drained and refiners and distributors found themselves uncertain where the next day's supplies would come from. Even more information on the subject has been revealed in the scarcities of 1947 and 1948, with refiners obliged to prorate supplies among their customers.

Future Higher Prices for Fuel Oil Seem Inevitable

There is at least one cheerful angle to this winter's fuel oil scarcity. There ought to be a fair chance that next winter's weather will be nearer normal, while it could almost as easily be even warmer than normal. Such weather, coupled with progress to be made in 1948 in expanding the industry's facilities, could help materially to balance the supply of heating oils with demand next winter. Even so, there would not be full assurance of ample supply, because of the further complication of the never-ceasing expansion of demand.

Available oils threaten to be "hogged" for heating purposes in place of using readily available coal, and in order to get these great volumes of fuel oils, the consumers henceforth will have to begin bidding more actively against users wanting the petroleum for automotive and other purposes in the form of gasoline and other quality products. Thus, relatively higher prices for fuel oils seem inevitable for the future, and this will be a good thing from the standpoint that it encourages use of coal for heating where available, thus leaving more crude oil for making gasoline and other products for which coal will not satisfactorily substitute. Encouragement of use of coal instead of petroleum where possible is desirable from the standpoint that U. S. coal reserves are very great, while reserves of petroleum and natural gas are uncomfortably small.

"Unselling" Campaign Not Likely to End This Winter

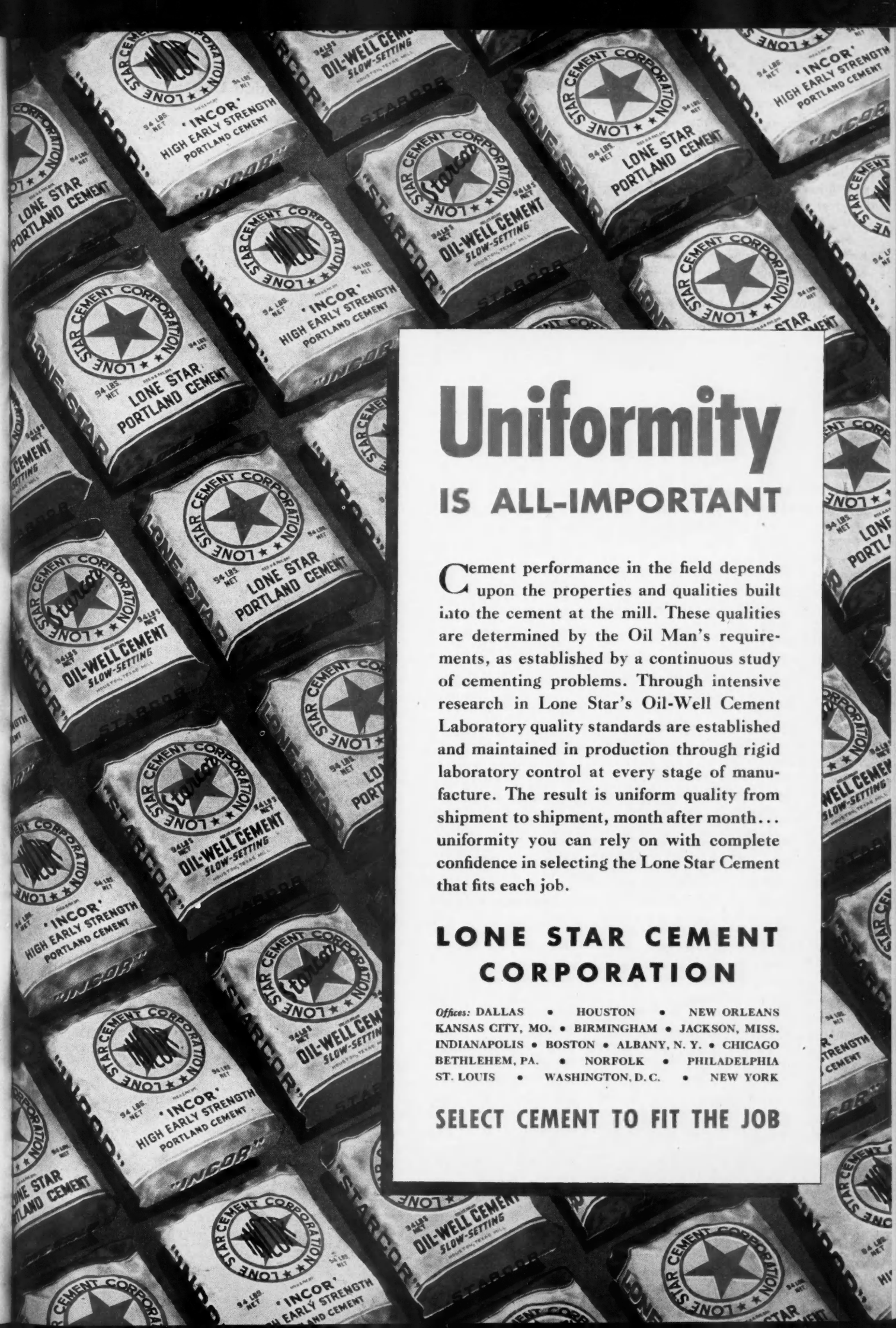
It was odd to see many oil companies "unselling" the public on consumption of heating oils this winter, in trying to hold demand within supply. Likewise, it is odd but true that oil companies apparently will not limit the "unselling" to one winter's campaign. There seems to be a growing conviction that too much oil is being burned where more plentiful coal could serve as well; that unnecessary use of oil should be discouraged in the national interest, with higher prices a necessary means of holding within reasonable bounds the burning of oils in furnaces. Back of this conservation thinking is the feeling of responsibility by oil industry leaders for assuring the nation adequate supplies of oils for purposes where coal will not serve, as military, naval, aviation, and automotive use.

One of the first to bring this important matter to the attention of the public was H. C. Wiess, president of Humble Oil & Refining Company, who declared that the oil industry was being criticized for shortages of fuels that should have been supplied in the first place by the coal industry, which has achieved no increase in production of energy source since World War I. (World Oil, January, 1948, page 29.)

Desirability of Burning Less Oil in Furnaces Is Stressed

The desirability of minimizing the burning of petroleum in furnaces and under boilers was discussed by Robert G. Dunlop, president of Sun Oil Company, at a Congressional committee hearing. He said that so far there has certainly not been any retarding effect by prices upon demand for heating oils. Domestic consumption of distillate fuel oils, including furnace oils, in 1947 was 23 percent above 1946 and 70 percent above 1941, he pointed out. The huge jump in consumption was attributed primarily to the installation in 1947 of more than 760,000 central oil heating units in homes and the production of approximately 1½ million oil-burning heaters.

"Obviously," said Dunlop, "the oil industry cannot keep up with such an accelerated demand for furnace oils over a period of several years without severe strain and disruption. Consequently, the practicalities of the situation require price increases, not only to stimulate more production but also—and just as important—to check the expansion of a



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demand for fuel oils that has been growing out of all bounds.

"The obvious fact is that oil cannot heat all the homes in the country, nor can oil continue, as it has in recent years, to supply virtually all the increase in the nation's energy load. This is a matter of great fundamental importance to the nation."

He presented three charts which demonstrated the increasing part of the energy load being carried by crude oil, natural gas, and natural gasoline. Between 1918 and 1947, 95 percent of the increase in energy has been contributed by petroleum and natural gas. Water power's share has been 5 percent and coal has been static.

From 1918 to 1947, it was stated, the U. S. energy potential of mineral fuels and water power has increased about two-thirds, from 21,739 trillion British thermal units to 36,323 trillion. Energy from petroleum in Btu's has grown almost five times, from natural gas and natural gasoline 6-2/3, while the energy potential of water power has slightly more than doubled. Energy from coal last year was slightly less than it was in 1918. Only once in the 1919-1947 period has coal supplied as much energy as it did in 1918, and that was in 1944, when its energy contribution was one-half of 1 percent greater than in 1918.

Relatively, continued Dunlop, the position of coal as a source of potential energy has deteriorated from 82.2 percent of the national total in 1918 to 48.8 percent last year. Not since 1944 has coal contributed as much as 50 percent of the national potential energy, and in 1946 petroleum and natural gas made a contribution slightly greater than coal.

Crude as a source of energy, however, bettered its relative position until 1938 when it accounted for 34.8 percent of the total. It has not since achieved that relative high, ranging since then between 33.5 and 27.8 percent of the total. Natural gas and natural gasoline, on the other hand, have grown steadily in importance as a source of potential energy, from 3.7 percent of the total in 1918 to a high of 15.1 percent in 1946, falling back to 14.8 percent last year.

If petroleum and natural gas are to continue to contribute their proportionate share of energy, declared Dunlop, then petroleum and natural gas facilities will have to be greatly expanded in the years immediately ahead, at cost of billions of dollars. This capital will have to be raised largely out of earnings, he added, and earnings depend on adequate prices of oils. Thus current prices serve the public welfare, for upon them depend adequate supplies in the future. Furthermore, he added, petroleum rapidly is becoming too valuable a commodity to be burned in furnaces and under boilers, and part of that load now carried by oil should be shifted to natural gas and coal.

Battle Joined in Claims To Control of Tidelands

Some oil industry leaders have professed to be disinterested in the outcome of the fight between the federal government and the states over control of the tidelands. Who the landlord is should make no difference to the oil operator, they say. Other oil industry men are contending that the public interest will be best served if the federal government surrenders its claims and leaves title and control to the states. This view is taken on the objection that federal administration will hinder and discourage development of the urgently needed tidelands oil reserves. Some business men and state authorities also vigorously oppose the federal tidelands claims as a further encroachment of the national government upon states' rights and as another move toward centralized, bureaucratic government, threatening even personal property rights.

On February 23 the fight came into nationwide attention when a joint House-Senate judiciary subcommittee began hearings on 32 measures proposed to either convey title to submerged coastal lands to the states or to quiet states' titles. Attorneys general and governors of the various states were voicing the claims of the states.

The Supreme Court last June 23 decided that California tidelands are owned by the federal government and not the state, with federal jurisdiction necessary for national defense purposes. This decision clouds title to lands off the shores of other states. However, Congress can by law quit claim to those lands. That it will do so appears quite possible.

Government Curbs Exports To Conserve Oil Supplies

Pressure for further curtailment or even a full embargo on petroleum and petroleum product exports has brought new governmental moves to save in this way oils urgently needed for domestic consumption.

The Department of Commerce on February 20 put crude oil exports under quota control that requires licensing of shipments to all destinations except Canada. This move followed on the heels of its second reduction in recent weeks in petroleum product export quotas for the first quarter of 1948.

Meanwhile, Representative Heselton, Republican, Mass., of the House Commerce Committee, actively sought a congressional ban on all oil shipments.

Campaign Under Way to Curb Sales of Burners and Heaters

From Washington pressure is being directed toward manufacturers of oil burners and space heaters for a voluntary program of curtailing production of these oil-consuming units until ultimate purchasers can be assured adequate supplies of fuel oils. Steel that could be saved in this way should be diverted to the oil industry to accelerate expansion of petroleum producing and refining capacity, it is pointed out.

Early action is being demanded, to head off a new sales campaign by oil burner manufacturers, which would result in the installation of additional thousands of new units without due consideration of the ability of the buyers to get fuel oils next winter. These recommendations that the oil burner manufacturers avoid excessive production and sales are being acted upon by the House Small Business Committee.

While this approach offers some promise as a temporary measure, some oil industry executives have misgivings about excessive oil burner sales even from a long range standpoint. More and more is being said about the advisability of burning oils in furnaces and under boilers when coal would serve virtually as well, since there are other uses of oil, as in most forms of transportation, where there are no satisfactory substitutes.

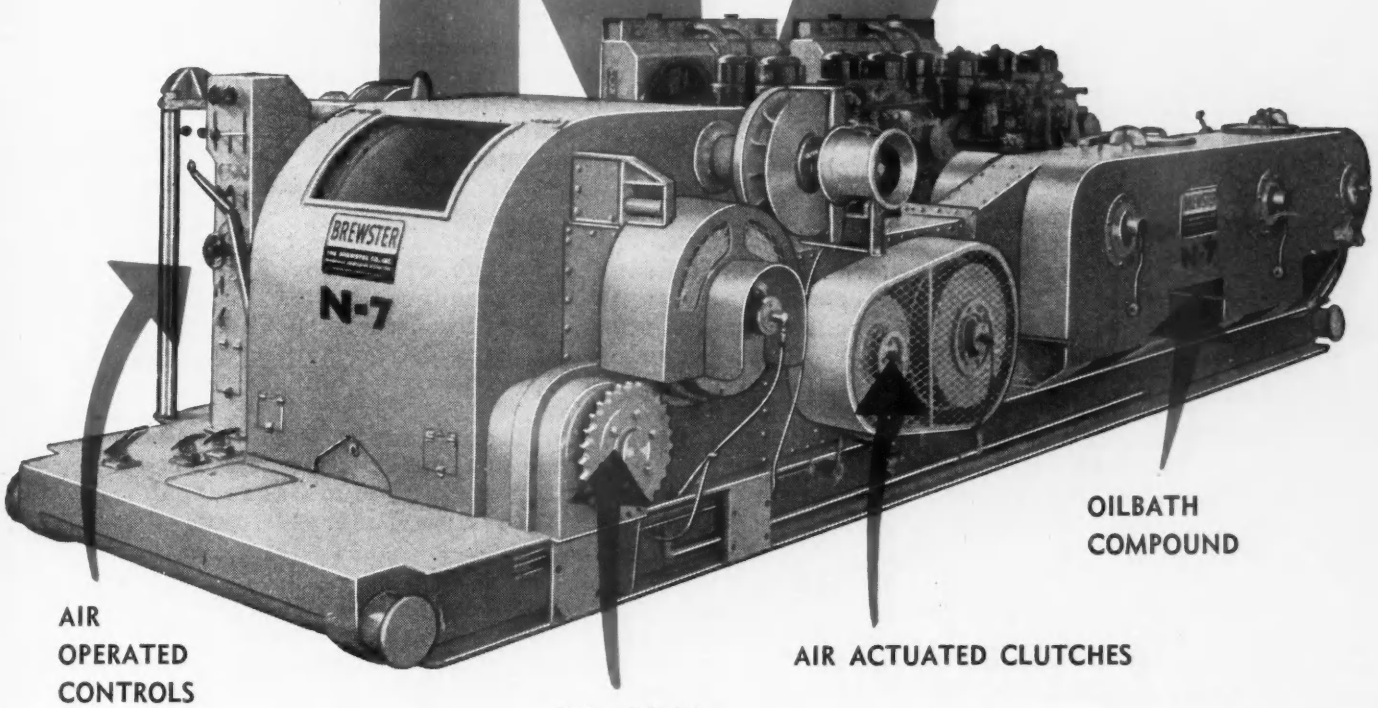
Summer Gasoline Shortage Debated by Forecasters

Gasoline shortages next summer are predicted in some quarters but doubted in others. Some forecasters say allocations of scarce supplies will be necessary again on the East Coast and possibly in the Midwest.

At the beginning of February, a representative of Standard Oil Company (N. J.) said he could foresee no need for industry-wide gasoline allocation. He pointed out that production of motor fuel was up 6 to 7 percent over 1947. While there will be no surplus, he said, "there ought to be enough to meet the demand."

However, in late February, William Murray, Jr., member of the Texas Railroad Commission, warned that Eastern motorists should recognize the possibility of gasoline shortages next summer. He based this statement on indications that it may be necessary to cut back production rates in Texas to avoid damaging the fields. Murray said Texas fields were producing at maximum efficient rates in trying to meet requirements for heating oil and that they might be unable to satisfy all demand for gasoline at the peak of the motoring season.

N-7 INCREASES DRILLING PROFITS



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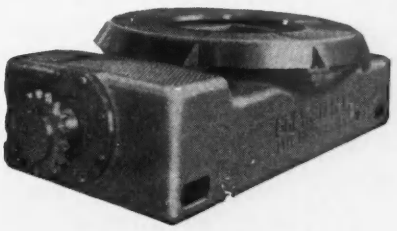

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Looking Ahead

FURTHERING Western Hemisphere defense, the U. S. henceforth will exert increased pressure upon Latin-American countries for vigorous development of their oil resources. Hemispheric sufficiency of oil was emphasized as important U. S. aim when representatives of all Latin-American countries, including Mexico, conferred at Washington February 24 with men representing U. S. defense establishment and state department, in meeting of Inter-American Defense Board.

A WAR emergency would find the U. S. facing shortage of oil by 2 million barrels daily, Defense Secretary Forrestal told a congressional committee. To help build up reserve producing ability in similar amount he urged encouragement of domestic drilling, development of a large synthetic oil industry, and importation of foreign oils to save domestic supplies.

COMMERCIAL SCALE U. S. production of synthetic liquid fuels will commence early in 1949. From dry natural gas, two plants now under construction, at Brownsville, Texas, and Hugoton, Kansas, will each produce more than 7500 barrels daily of high octane gasoline, distillate fuel oil, and other products.

GOVERNMENT control of petroleum industry, as proposed, will gain virtually no effective support, it is indicated, if the industry keeps working vigorously on expanding supply, thinks long before further raising prices, and fully informs the public about its problems and its efforts.

OIL COMPANIES and oil operators can look and plan ahead now with somewhat more confidence than formerly because public opinion now trends strongly toward upholding the private enterprise system and against government controls or ownership. A recent survey on American railroads showed that the percentage of people favoring public ownership of the railroads declined from 46 percent in 1941 to 12 percent in 1947.

A THIRD nationwide increase in wages, now being demanded by union leaders, may bring something new in the form of widespread public disapproval. A poll of top standing shows that already 53 percent of the public opposes another round of wage increases because it is certain to run prices up higher. Only 45 percent of union members still favor a wage increase, 39 percent are against it, and 16 percent are undecided.

U. S. NAVY'S Alaskan petroleum reserve promises to yield ultimately 500 million barrels, a congressional committee was told by Commodore W. G. Greenman, chairman of the reserve's operating committee. High hopes are based on widely scattered oil and gas seepages, oil sands in three wells on Umiat structure in southeast, and showings in a well and several core holes at Cape Simpson, 150 miles to northwest on Arctic Coast.

DURING REMAINDER of current heating season, oil industry on East Coast cannot fall back on stocks but will have to meet heating oil demand in so far as possible strictly from current production, says A. J. McIntosh, economist for Socony-Vacuum Oil Company. Districts 1 and 3 now have only minimum working stocks of distillate fuel oil and kerosine, he stated.

FOR NEXT heating season available supply of distillate fuel oil will be about 12 percent above this winter's supply, Interstate Compact Commission report estimates. Any increase in demand above this amount cannot be guaranteed of a supply, prospective buyers of new oil burners are warned, as installations actively proceed.

NEED FOR *Synthetic* FUEL INDUSTRY

By L. J. LOGAN,
Associate Editor

BECAUSE of shortages of petroleum during and after World War II and the fear of serious future shortage, interest in synthetic liquid fuels has been greatly encouraged. Just as the nation solved its almost disastrous wartime loss of natural rubber supply by developing synthetic rubber, so it now considers quite seriously the need for setting up facilities for large-scale synthetic production of liquid fuels to supplement natural petroleum production.

The consideration of this subject has now culminated in the introduction of a bill in Congress seeking to assure construction of three large synthetic plants underwritten by the government. The Secretary of the Interior, with support from the Secretary of Defense, has recommended that the U. S. start at once on a $9 billion program of construction of synthetic liquid fuel plants. The plants would be built within five to ten years, with government financial aid if necessary, and would provide a synthetic liquid fuels industry capable of producing 2 million barrels of products per day. The bill for immediately starting three plants would be the first step in the program recommended by Secretary of Interior Julius A. Krug, with approval of Defense Secretary James V. Forrestal.

This bill H.R. 5475, introduced in the House by Chairman Wolverton, Republican, New Jersey, of the Interstate and Foreign Commerce Committee, would authorize construction of three basic commercial-scale, 10,000 barrels per day synthetic liquid fuel plants for a total maximum cost of $400 million. Under provisions of the bill these plants would be of three different types and would each have a capacity of not less than 10,000 barrels per day of liquid fuels. The three plants would be of these types: (1) for hydrogenation of coal, (2) for synthesis of liquid hydrocarbons from gases produced from coal, and (3) for production of shale oil from oil shale. The plants would be constructed with the technical advice of the U. S. Bureau of Mines, which is carrying on research in synthetic liquid fuels under another law that is to be extended.

By specifically calling for the above three types of plants, the bill would leave to private industry a fourth class of synthetic liquid fuel plant; converting dry natural gas into gasoline and distillate fuel oil by the Fischer-Tropsch process. Presumably, this type was omitted because there is already a start on commercial development of this kind of production. Two such plants, one at Brownsville, Texas, and the other in the Hugoton area, Kansas, are under construction, at a cost exceeding $15 million each, and each of them will produce about 7500 barrels per day of liquid fuels from dry natural gas. These plants promise to be commercially competitive with refineries making similar products from crude petroleum, and it has been estimated that production of this kind will climb to at least 200,000 barrels daily by 1956. Another consideration, probably, in leaving this development to private industry is the fact that natural gas reserves, though large, are small in comparison with coal reserves and do not warrant too large a gas-to-gasoline synthetic industry, especially in view of the desirability of natural gas as a fuel in its natural state.

Because coal reserves are very large in comparison with reserves of crude and natural gas, the current clamor for synthetic development lays principal emphasis on utilization of coal for making liquid fuels. Of the three proposed plants, two would make use of coal, one by hydrogenation and the other by changing coal into gaseous then liquid form. The third type plant would seek to develop more satisfactory extraction of oil from oil shale, present methods being non-competitive with crude oil refining.

Under the Wolverton bill, the Reconstruction Finance Corporation would be authorized to extend funds to private interests for building the plants and if plants were not so built, RFC would have to build them, then lease them to private interests for operation.

Wolverton said hearings of his committee convinced him that military and economic security required prompt steps toward a synthetic liquid fuel industry, so handled as not to replace domestic crude production or imports of foreign oils, and with due regard to the need of using steel moderately.

While the Krug recommendation contemplates use of 16 million tons of steel and a total cost of $9 billion to develop 2 million barrels per day of synthetic capacity, Wolverton said:

"To suggest to Congress at this time to approve such expenditures would be pure foolishness and would merely serve

to deteriorate, so far as the next three to five years are concerned, our petroleum situation, since it would consume the steel which is so urgently needed at home and abroad to supply us with domestic and imported crude. On the other hand, it is wisdom to set aside a small portion of the steel which generally will be available during the next three years, to construct the three basic plants which will advance immeasurably our ability to increase domestic production of liquid fuels should the need therefor increase."

The large-scale synthetic industry recommended by Secretaries Krug and Forrestal assume a necessity to create reserve capacity in the U. S. to supply perhaps 2 million barrels daily additional liquid fuel in time of war. Reflected in their recommendation is serious doubt that such reserve producing capacity can be built up while limiting efforts to crude oil development, considering present and prospective tremendous requirements. Also reflected is recognition of the fact that foreign oils can not be depended upon for emergency needs.

The Krug recommendations were embodied in an annual report to Congress on progress of the government synthetic liquid fuels research, and they made these assumptions: (1) that the need for a synthetic liquid fuel industry is clear and urgent, from a national defense standpoint; and (2) that such an industry will not be initially competitive with the crude oil industry and therefore requires government assistance.

"At this stage in the development of synthetic fuels processes, with the competition of cheaper petroleum still prevailing and the future clouded with uncertainties," stated Krug, "it is doubtful that private industry will find the investment sufficiently attractive to warrant starting plant construction without governmental assistance in some form." Krug recommended as a starter on his proposed program the immediate construction of three commercial-scale plants, and this recommendation was embodied by Wolverton in his bill.

Krug said that establishment of a synthetic liquid fuels industry is "far too large an operation and requires too much time to be undertaken under wartime emergency conditions." He said that a synthetic fuels program would be 10 times greater than the wartime synthetic rubber program.

Along with the recommendations discussed above, Secretary Krug cited skyrocketing demand for petroleum products and the uncertainty that domestic supplies would overtake that demand in the future and urged immediate action on legislation pending in Congress to extend the synthetic liquid fuels research program from June 30, 1949, the scheduled expiration date, until June 30, 1951, and to appropriate another $30 million for the project. Both House and Senate have passed this bill but a minor difference in House and Senate versions has to be compromised. Krug stated that all research laboratories and the oil shale demonstration plant contemplated under the existing legislation are now in full operation and that a coal hydrogenation demonstration plant, to be located at Louisiana, Mo., will be in service by next summer.

Oil Shale Plant

In regard to oil shale, Secretary Krug's report stated that at Rifle, Colo., a demonstration plant produced its first crude shale oil last May, when retorts were put in operation. Since then, production has been at the rate of about 50 barrels daily, and now three additional types of retorting units are being built. The present estimated cost of producing crude shale oil on a large scale is roughly $2 to $2.50 per barrel, according to the report. "This oil would not compare favorably in quality with oil produced from natural petroleum now selling at those prices but if the recent trend toward price increases continues, it will be easily competitive."

By relatively simple refining, crude shale oil yields No. 5 or No. 6 residual fuel oil suitable for use in ships or utility plants. But further improvements in refining will be necessary to produce distillate fuel oil, diesel fuel, and gasoline on a commercial basis. In order to speed up studies of the government on refining methods, it will unretake a coporeative program with a number of oil companies.

The demonstration plant at Louisiana, Mo., for converting coal into oil will be completed this year. It will produce about 200 barrels per day of gasoline by the hydrogenation process. Under present conditions it is estimated that high grade motor gasoline or aviation gas can be produced through this process for about 14 cents per gallon, about 5 to 7 cents more per gallon than the current cost of gasoline from petroleum. In this estimate no credit is given for by-products which may reduce the cost in some plants by 3 to 5 cents per gallon. The estimate does include allowance for plant amortization and production costs.

In testimony before the Short armed services subcommittee of the House both the long-range and short-range Krug recommendations were challenged by Bruce K. Brown, chairman of the military petroleum advisory committee and vice president of Standard Oil Company (Indiana). He declared that first preference must be given to producing liquid fuels from crude petroleum because such production is so much less costly in steel and manpower than production by any other method. "I am convinced," he said, "that we can get more oil—quicker—by making steel available to the oil industry than by any other method."

Even the starting of a few large synthetic plants at this time, he said, "would, because of their enormous requirements for steel, cut down the immediate availability of oil by depriving the industry of steel it needs this year and next year."

Brown took the view that if crude oil becomes seriously scarce, all the really needed liquid fuels can and will be synthesized by private industry from natural gas and coal. In this connection, he contended that synthetic liquid fuels are and will remain practical only in such forms as aviation gasoline, motor fuel, or diesel oil, where coal or other substitutes cannot be used. The synthetic fuels are too costly and wasteful of the original heat value of natural gas and coal to be made for use in furnaces and under boilers, he asserted. "It would be folly," he declared, "to sponsor a national program to subsidize the production of liquid fuel to burn under boilers." The country "cannot afford to build plants to make fuels to heat houses," because "we're just not that rich."

To produce 2 million barrels per day of synthetics from coal, said Brown, would require 468 million tons of coal per year or more than two-thirds as much as was ever produced in a single year. To synthesize only about 500,000 barrels per day of liquid fuel, he said, all of the available natural gas produced in the U. S. in 1946—4.83 trillion cubic feet—would have been required, with nothing left for electric power from gas, for industrial use, or for heating factories, commercial places, and homes.

Brown did not challenge the practicability of synthetic liquid fuels "to power the really efficient mechanisms where they are needed and for which there is no substitute." But he emphasized that "using liquid oil to power a plane, a train, a ship, or an automobile is quite a different thing from using it to heat a house or drive the generators in a city power plant."

Asked what Congress could do to assure adequate supply of oil for an emergency, Brown said one of the most important things should be to establish and maintain the best possible relationships with South America as the "safest source" of oil outside the U. S. He also recommended that the oil industry get more steel to develop domestic reserves and that everything possible be done to facilitate development of tidelands oil. In the latter connection, he urged that the federal government turn title over to the states because administration of the lands by a federal agency would obstruct development.

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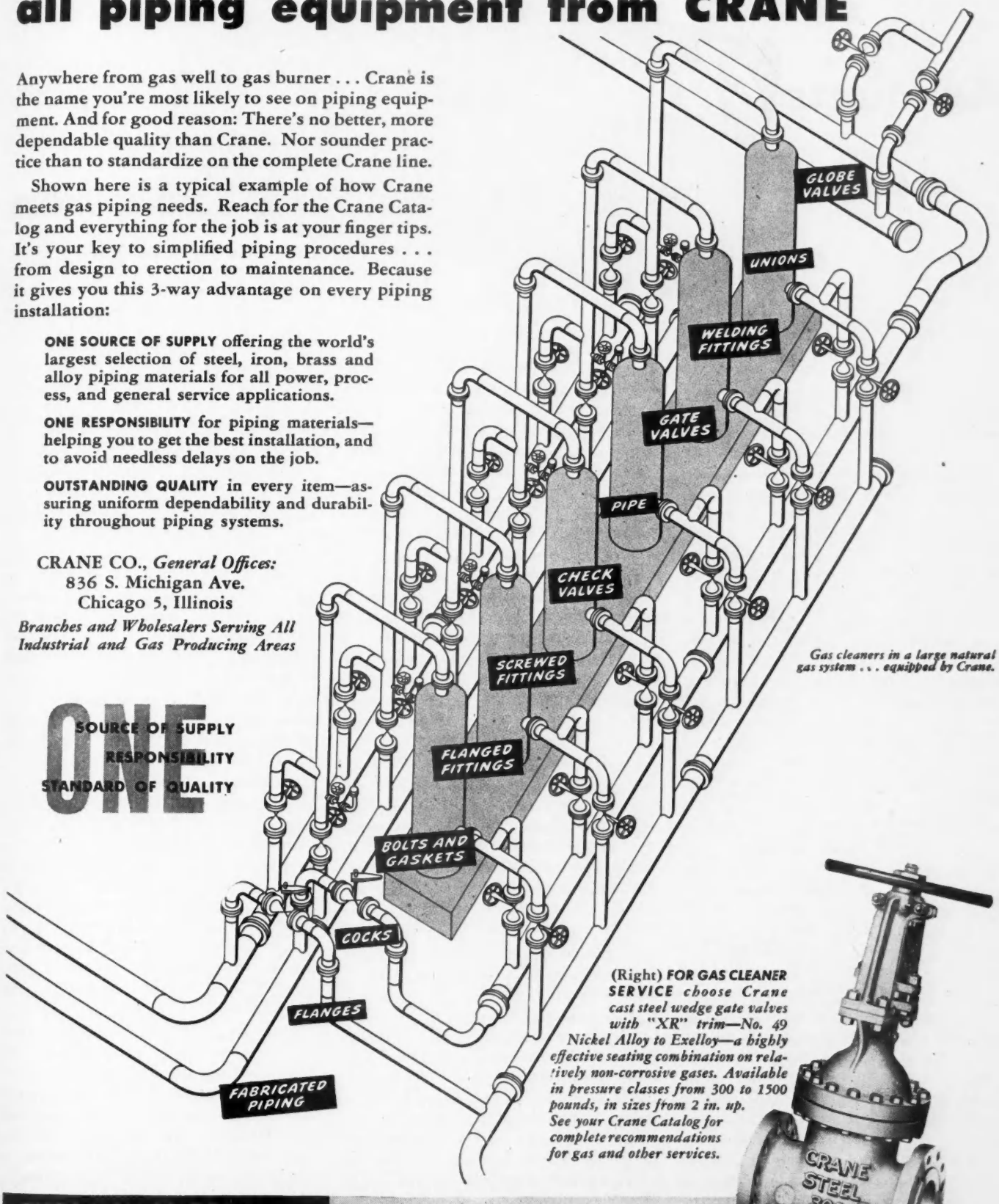

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Adequate Oil Prices and Tax Relief Needed to Achieve Expansion

By HENRY OZANNE
Staff Writer

THE petroleum industry must expend in the next five years more than $13 billion in an unprecedented world-wide expansion program if it is to meet adequately the demands of the consuming public, it has been authoritatively estimated. In the U. S. alone more than $4 billion is being spent in 1947 and 1948 for expansion.

The current general price structure and tax structure offer considerable doubt that this vast expansion can be financed to a normal extent out of earnings, although improved oil prices admittedly will help to raise needed funds. To a possibly greater than normal extent, the industry may have to resort to the two other customary ways of raising capital; by the sale of stock issues and through borrowing.

There is a natural saturation point rather quickly reached in issuing new stock however, and rising interest rates prevent excessive borrowing. As interest rates rise, further investment in the industry slows. Quite conceivably, the industry could run into considerable trouble in raising needed capital.

To succeed in raising the large amounts of new capital urgently needed for expansion, the industry stands clearly in need of two measures of assistance: (1) attainment and maintenance of a balance between the industry's price structure and the price structure of the national economy in general; (2) overhauling of the tax structure so that business is not crippled under the tax load and so that investors are not discouraged by double taxation. Favorable prices are necessary for all divisions of the industry. Earnings must be sufficient in each division to encourage expansion in refining, transportation, and marketing, as well as production.

This matter of the ability of the industry to achieve needed expansion is one of not merely intra-industry importance but of national and international significance. The oil industry has a dominant role in the world recovery program. The fundamental role that oil is playing in the economy of all nations at present is emphasized by the current winter's fuel oil shortage, the volume of petroleum commitments in the European recovery plan, and the world-wide search now under way for new petroleum sources.

Venture Capital Needed

Some authorities believe that the industry faces a shortage of that essential type of funds called "venture capital" or "equity capital," while at the same time being unable to generate from its own earnings a normal proportion of its capital needs. Thus it is feared that trouble lies ahead in obtaining all needed capital.

Of the three traditional sources of investment capital, earnings, sale of stock, and borrowing, the first has been of predominant importance. In the words of Dr. Joseph E. Pogue, vice president of the Chase National Bank, and a foremost petroleum industry economist, "This is indeed quite proper if the industry is to remain self-reliant and not become a burden on the general economy." Dr. Pogue computes that in 1946 a representative segment of the oil industry, consisting of 30 leading companies, "generated from its own operations 89 percent of the capital required to maintain itself as a going concern. This ratio has varied only slightly through the years, as indicated by the fact that at the close of 1946 the borrowed capital of the group was 12.6 percent of the total capital employed. In short, the industry normally finances seven-eighths of its maintenance and expansion out of its own operation."

Dr. Pogue further estimates that for 1947 cash income of the same group of 30 companies will provide only 86 percent (rather than 89 percent) of capital expenditures. This decline, many in the industry argue, is symptomatic of a declining ability of the petroleum industry to "pay its own way" and will necessitate larger borrowing. This, in turn, will advance interest rates and prove a deterrent to new capital entering the industry, and thereby impede the entire expansion program.

W. H. Garbade, assistant treasurer of the Shell Oil Company, has pointed out that "interest rates are rising faster than they have at any time during the past nine years and are naturally dampening corporate enthusiasm for additional borrowing. Consequently—and in spite of a high profit level—these circumstances are forcing many companies into a rapid depletion of cash as they proceed with necessary expansion of plant facilities."

However, Dr. Pogue told WORLD OIL: "Venture capital for industry has become scarcer, but the cash production of the oil industry has become so augmented by the higher price structure that I suspect that the general feeling that the industry must have wide recourse to equity financing is probably exaggerated. I doubt if we will witness in 1948 as much new financing as we did in 1947.

"I expect interest rates on borrowed money to move somewhat higher, but I doubt if that will be too much of a deterrent in light of existing profit trends. It will be more difficult, how-

ever, I think, to obtain money for marginal types of loans."

Generally, management thinking in the petroleum industry materially discounts current reported profits. W. Alton Jones, president of Cities Service Company, feels that the oil-producing industry "is selling goods off the shelf". at less than replacement cost. He told the Interstate Oil Compact Commission at its December meeting:

"A producer of oil in 1947 is selling oil that was paid for in the form of drilling rigs, pipe, valves, fittings and labor at prices prevailing five or more years ago." He added that some competent petroleum engineers compute that $102 billion has been invested in the discovery and production of oil from the Drake well to the present time. "And it appears," he said, "that at the posted field price the oil recovered had a gross value of $61 billion, leaving a debit balance," and hence overall there has been no real profit in the industry at all.

This question of profits is a highly complex one, all industry authorities agree, and currently declared profits are not a realistic appraisal of the industry's present financial position. Many industry executives deplore the tendency to apologize for profits. The economists have long pointed out that profits are a vitally important mechanism for financing essential activity. Garbade of Shell says: "Corporate management finds itself in the embarrassing position of explaining, defending or even apologizing for its income. Obviously, if earnings were accurate gauges of corporate efficiency, management should take full credit instead of presenting alibis. For high earnings are absolutely necessary to support America's position in a world at peace, and they are just as indispensable to the revitalizing of private enterprise."

Alexander Fraser, president of Shell Union Oil Corporation, says that lowered purchasing power of the dollar makes profits currently reported by American industry only about half as large as they appear. "This is brought about," he says, "by the fact that the oil industry, which is characterized by heavy capital investments, must reinvest a very large share of their 'reported' profits in replacement of plant and equipment."

He says that the group of 30 oil companies, showing a profit of $763 million in 1947, paid out less than half of their reported "profits" to stockholders and retained the greater part of their earnings to reinvest in the business. This indicates how much money over and above normal depreciation is required for normal replacement of capital equipment.

He stresses that the reinvestment of a large portion of current profits is particularly necessary in the oil business. He points out that the industry has a very high capital investment in relation to most business and that the rapid pace of petroleum technology often renders costly equipment practically obsolete before it is in actual operation.

Fraser says: "The petroleum industry requires something on the order of an investment of $1.12 in plant and equipment for every $1 of annual sales of petroleum products. This is a tool cost four times greater than that of other major industries. For the automobile industry, the figure is 38 cents; for the rubber industry, 30 cents; for steel, 63 cents."

In connection with the reduced purchasing power of the dollar, Fraser stressed that just as the working man's take-home pay buys less meat than it did before the war, the corporation's take-home pay, or profits, buys fewer tools, equipment and plants. "In 1937," he cites, "it took $7.45 worth of refinery equipment to produce a gallon of gasoline. Today it takes $27.40."

Earning Inadequate

Actually, present oil company earnings are inadequate to provide enough cash, after dividends, to finance expansion needs, in the opinion of Gilbert H. Palmer, investment analyst for the National City Bank, Cleveland. Neither, he warns, can the petroleum industry continue its good dividend record if it is forced to meet capital needs through new stock issues. Palmer points out that in 1946, for the first time in eight years, the group of 30 oil companies spent for capital purposes an amount larger than total cash available from earnings after dividends. He concludes that the industry is under-financed for current needs, and estimates that new money required by the group of 30 companies might total $500 million for 1947 in addition to the $1735 million available from cash income.

TABLE 1

Facility or Area	Million Dollars	Percent of Total
Facility		
Crude producing	7,000	53
Pipe lines	1,000	8
Marine Equipment	500	4
Refining	3,000	23
Marketing	1,400	11
Others	200	1
Total	13,100	100
Area		
U. S.	7,500	57
Middle East	1,650	13
Europe (exclud. Russia)	1,275	10
South America	1,200	9
Far East	450	3
Others (includ. Russia)	1,025	8
Total	13,100	100

Future financing needs of the oil industry are vast, all authorities agree. Dr. Pogue, in collaboration with Frederick G. Coqueron of the Chase National Bank, estimates that the industry will require expenditure of about $13 billion for the five year period 1947-1951. Their estimates of capital expenditure by the industry for this period are shown in Table 1.

Pogue and Coqueron also present the table below of financing transactions by the group of 30 oil companies for the first nine months of 1947.

Source and Disposition	Million Dollars	Percent of Total
Source of Funds		
Borrowings	199	58
Preferred stocks	29	8
Common stock	115	34
Total	343	100
Disposition of Funds		
Retirement of Debt	84	25
Acquisition of Assets	15	4
Added to working Capital	244	71
Total	343	100

An estimate by the API places the figure at $4095 million as the capital expenditures needed by the industry for 1947-1948, while Dr. Robert E. Wilson, board chairman of Standard Oil Company (Indiana) reported to stockholders that the petroleum industry has need to spend $3000 million every year for several years in the future for new facilities and improvements.

Palmer emphasizes that the industry, faced with the necessity of going to the public with new stock issues, must offer investors strong reasons for putting their savings in the industry. A number of new financing programs have been announced by various oil companies. Sinclair Oil Corporation recently borrowed $50 million from an insurance company in the form of 25-year, 2⅞ percent sinking fund debentures, in order to "provide aditional funds for completion of its expansion and modernization program, and for future needs." The Texas Company floated a $100 million new stock issue. Tide Water Associated Oil Company has announced a private issue of $48 million in 25-year debentures to purchase shares currently held by Mission Corporation and Pacific Western Corporation. Standard Oil Company (Ohio) has announced plans for new issues of both common and preferred stocks to expand crude production facilities. Continental Oil Company said its $40 million expansion program would be met largely through retained earnings plus bank loans. Phillips Petroleum Company is issuing 1 million new shares of common stock to

■ CONTINUED ON PAGE 51

Earnings Exaggerated

Unless Adjusted To Reflect High Replacement Costs

By W. H. GARBADE
President, Deep Rock Oil Corporation

FEW subjects are currently commanding more interest in business circles than the problem of accounting for replacement costs. The question has been discussed in considerable detail in many recently published articles. It was thoroughly aired at a recent meeting of petroleum industry representatives, and it is doubtless prominent in the minds of management in every major industry.

As is inevitable with such controversial topics, all the discussions have been marked by fairly general disagreement. Few authorities in any field agree on the best method of reflecting increasing replacement costs in financial reports. And experts in accounting and other professions are choosing sides for another clash in the "battle of the footnotes."

Probably the one obvious conclusion to be drawn from all that has been said and written so far is that there is no simple cure-all for the problem. Every solution that has been proposed appears to fail in one way or another, depending on the individual case. In discussing the subject, then, it seems reasonable to sketch in the background against which the main problem revolves. In this way, perhaps, we can highlight the basic issues confronting management as it seeks to formulate a sound approach for individual companies.

Earnings Exaggerated

The first factor to be considered is that earnings in America, expressed in dollars, are at an all-time high—as shown in Figure 1. Furthermore, corporate management finds itself in the embarrassing position of explaining, defending or even apologizing for its income. Obviously, if earnings were accurate gauges of corporate efficiency, management should take full credit instead of presenting alibis. For high earnings are absolutely necessary to support America's position in a world at peace, and they are just as indispensable to the revitalizing of private enterprise.

Unfortunately, however, management can take little credit for today's earnings, because they are largely fictitious. According to the Department of Commerce, corporate earnings in 1946 totaled $12.2 billion, of which inventory profits accounted for 38 percent. Add to this the distortion and exaggeration in profits caused by the use of prewar facilities in a postwar price structure and you see that profits quickly approach modest levels.

Capital Expenditures Unprecedented

Working hand in hand with the factors just mentioned are unprecedented capital expenditures throughout American industry. Money now being spent in the U. S. for replacement and expansion of plant and equipment is at an all-time high. In 1947 alone, corporate expenditures will total $16 billion—2½ times the normal prewar replacement capital expenditure rate of $6.6 billion. The petroleum industry spent one-eighth of this sum. But like others, the petroleum industry would much prefer to postpone present rates of expenditure until materials and man-power are in better balance with demand. In fact, the capital budgets of most companies provide only for urgently needed plant replacement and expansion to take care of essential consumer requirements, both at home and abroad. It is no secret that meeting these requirements cannot be delayed without serious economic and political repercussions.

One of the main reasons for the unprecedented capital expenditures is the current peak in construction costs. Figure 4 shows what this means. According to the Bureau of Labor Statistics, wholesale commodity prices have now reached the World War I peak and are almost double those of the prewar years. Furthermore, the chart shows construction costs are now approximately 70 percent above their prewar levels and equally as far above the peak levels reached in 1920. The graph also shows that construction costs receded only slightly following the first World War. It is doubtful that there will be any major decline from today's level, because of advances in wage rates and the artificial restrictions against technological improvements in the construction industry.

With all these forces working against real—as opposed to apparent—earnings, it is only natural that industry should find its cash depleted. During previous booms, when capital expenditures and earnings were at record levels, corporate enterprise was able to pay generous dividends and at the same time expand plant facilities through the medium of additional capital—capital that was either borrowed or raised through new stock issues.

Today, unfortunately, financing is not so simple. Tax rates are designed to discourage private capital accumulation and investment. The market for stocks suffered a severe setback in 1946, and investor enthusiasm has yet to recover from this blow. In other words, management is reluctant to propose new issues of common stock at today's price levels and in the face of lukewarm demand. Borrowed capital, although financially less attractive, enjoys a better market than stock, but even the market for borrowed capital is declining. Interest rates are rising faster than they have at any time during the past nine years and are naturally dampening corporate enthusiasm for additional borrowing. Consequently, and in spite of a high profit

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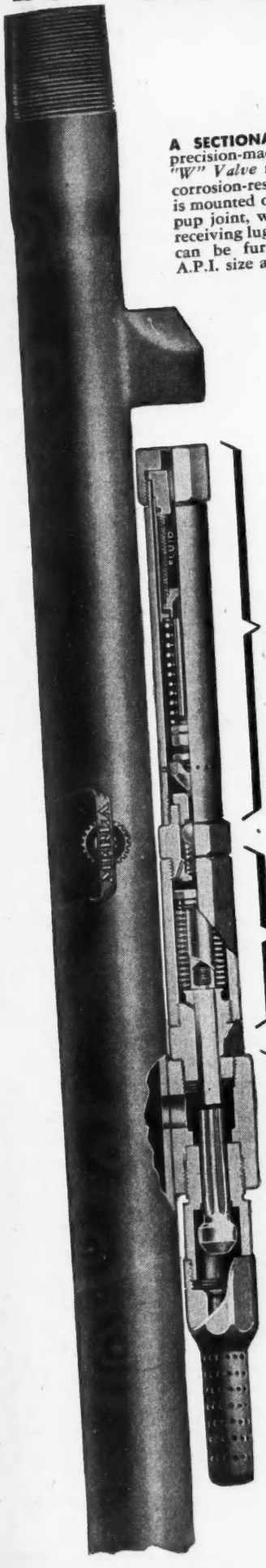

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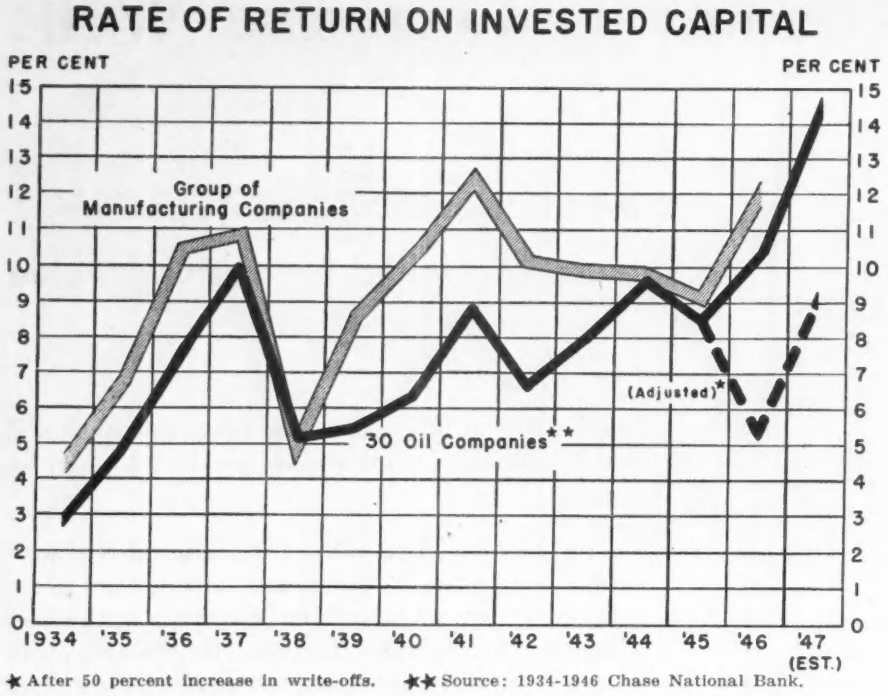

RATE OF RETURN ON INVESTED CAPITAL
PER CENT
PER CENT
Group of Manufacturing Companies
(Adjusted)*
30 Oil Companies**
1934 '35 '36 '37 '38 '39 '40 '41 '42 '43 '44 '45 '46 '47 (EST.)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

★ After 50 percent increase in write-offs. ★★ Source: 1934-1946 Chase National Bank.

FIGURE 1

level, these circumstances are forcing many companies into a rapid depletion of cash as they proceed with necessary expansion of plant facilities.

Pressure on Management

Besides coping with the problems we have just mentioned, management today is under considerable pressure because of the simple fact that earnings do not reflect replacement costs. This pressure is bearing down from three directions—from employes, from stockholders, and from internal operations. Organized labor and other employes, as well as stockholders, are "reluctant" to understand why management cannot increase wages and dividends. The reason for management's stand is graphically illustrated in Table 1. After allowing for a 50 percent increase in depreciation charges during 1946—to provide for increased replacement costs—30 leading oil companies paid out almost 90 percent of their adjusted earnings in dividends. If the industry continues to distribute earnings at this rate, it eventually will be forced to finance almost all new expansion, as well as increases in dividends out of new capital, probably borrowed.

Internally, of course, all operating costs are completely distorted unless they are adjusted to reflect current replacement costs of plant and equipment. The manager who calculates his costs, profitabilities and price structure on prewar capital costs is living in a fool's paradise just as dangerous as that occupied by the business man who budgets 1948 profits on prewar labor rates.

With a few exceptions, such as service agencies, the problems involved in accounting for replacement costs apply to industry at large. With the petroleum industry, however, the problem is a special one—and for an important reason. The greater the amount of plant and equipment required by an industry, the more acute is the problem inherent in exaggerated earnings attributable to prewar charges for capital. As shown in Table 2, industries require a widely varied proportion of investment in plant and equipment with regard to sales. Petroleum, with more than $1 of investment per dollar of annual sales, is close to the top of the list. Figure 1 shows what this means to the oil industry. With an adjustment of 50 percent in depreciation charges, oil companies' earnings, instead of representing an estimated 15 percent return on invested capital for 1947, are actually reduced to approximately 9 percent. (No adjustment for invested capital base.) Figures 2 and 3 show how a similar adjustment causes a drastic reduction in oil and steel earnings as a percentage of sales.

There is no escaping the fact that the problem of acounting for replacement costs is of industry-wide scope and definitely serious character. It can be summed up as follows: with no changes in today's levels of prices, wages, material costs, dividends, capital expenditures, construction costs, or any other factors, under accepted accounting methods, profit and loss results will gradually decline year after year until all prewar plant and equipment have been replaced. If management sets a dividend rate equivalent to today's earnings and maintains the rate unchanged for the next ten years, it will have paid stockholders largely out of capital rather than out of earnings—obviously an unhealthy situation.

Arguments most commonly presented on the subject of replacement costs have

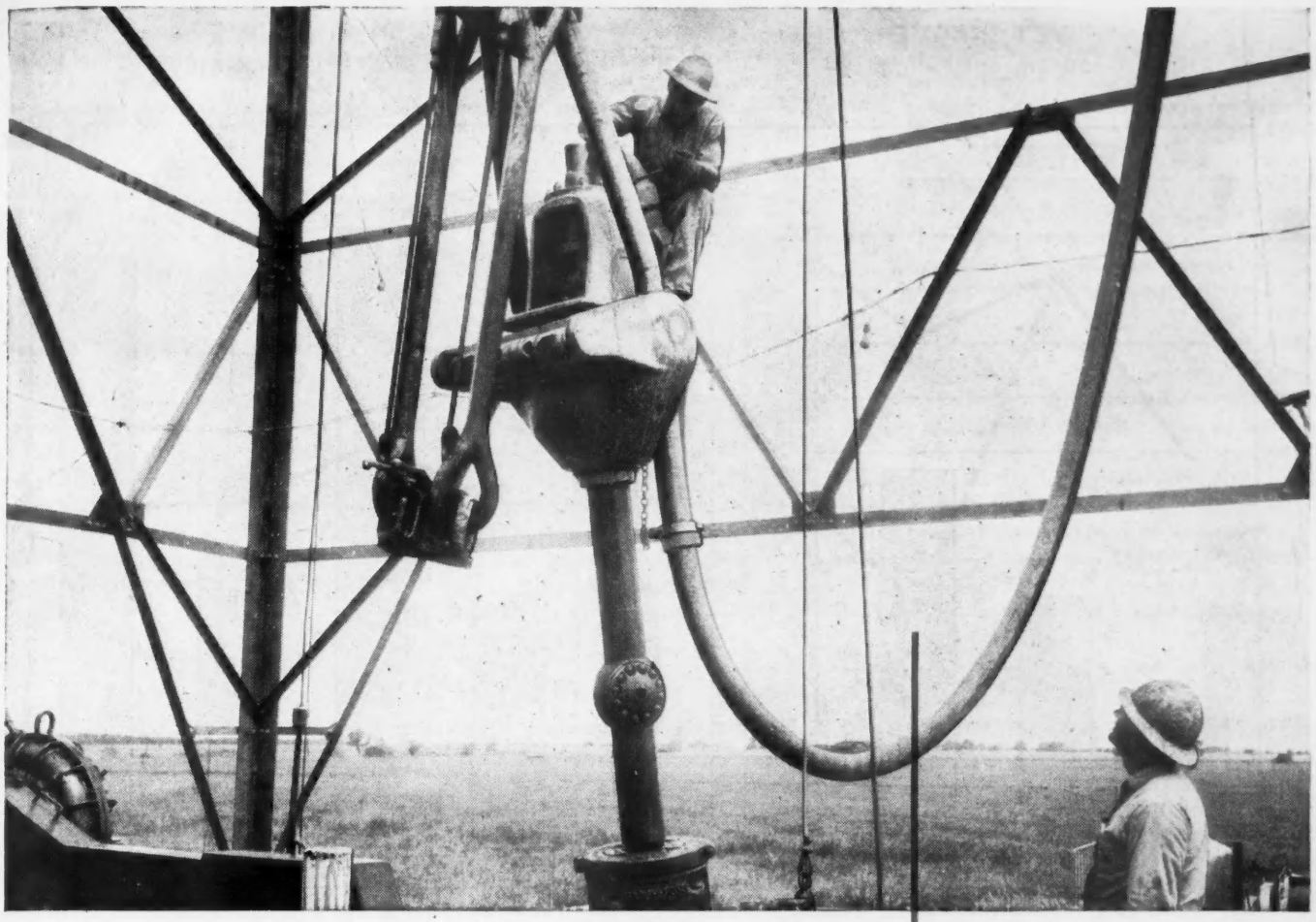
TABLE 1

Twelve Oil Companies—Earnings 1946 Actual and Adjusted—1947 Estimated and Adjusted

Millions of Dollars

	EARNINGS					DIVIDENDS					
	1946 Write-offs	1946 Reported	1946 Adjusted	1947 (b) Estimated	1947 Est. Adjusted	1946 Actual	1946 % of Earnings	1946 Adj. % Earnings	1947 Estimated	1947 Est. % Earnings	1947 Est. Adjusted % Earnings
Shell*	$ 25.0(a)	$ 32.9	$ 20.4	$ 53.9	$ 41.4	$ 20.2	61.4%	99.0%	$ 26.9	49.9%	65.0%
Standard-N. J.	154.8	177.6	100.2	273.3	195.9	82.9	46.2	81.8	109.3	40.0	55 8
Standard-Calif.	39.6	67.0	47.2	94.3	74.5	29.9	44.6	63.3	41.6	44.1	55.8
Standard-Indiana*	51.9	67.6	41.6	91.7	65.7	26.7	39.5	64.2	30.6	33.4	46.6
Socony	66.0	58.3	25.3	93.5	60.5	23.4	40.1	92.5	31.2	33.4	51.6
Texas	58.5	71.1	41.9	84.4	55.1	33.7	47.4	80.4	33.7	39.9	61.2
Gulf	59.4	58.3	28.6	86.2	56.5	22.7	38.9	79.4	25.0	29.0	44.2
Sun	9.6(a)	10.9	6.1	25.1	20.3	3.4	31.2	55.7	4.1	16.3	20.2
Atlantic*	24.7	9.6	(2.7)	15.2	2.8	4.0	41.7	200.0+	4.0	26.3	142.9
Sinclair*	27.6	27.6	13.8	38.9	25.1	12.0	43.5	87.0	12.0	30.8	47.8
Pure	15.1	17.1	9.9	24.1	17.0	5.0	29.2	50.5	6.0	24.9	35.3
Ohio	14.2	18.3	11.2	29.5	22.4	8.2	44.8	73.2	11.5	39.0	46.9
30 Oils (c)	716.0	763	382	1137.0	679	331.0	43.4	86.6	406.6	35.8	52.2

(a) Excludes intangible development expense. (b) Earnings and dividend estimates: Standard and Poor's Corp. (c) Chase National Bank, 1946.
* War Emergency Facilities written off for book purposes. Note: Adjustment is for 50 percent increase in write-offs.



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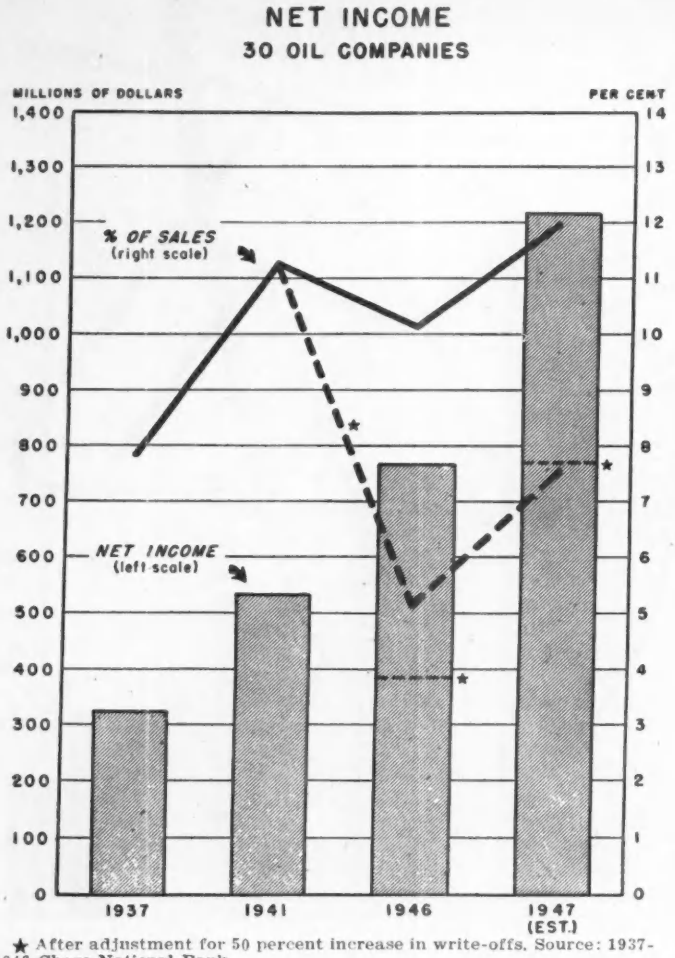
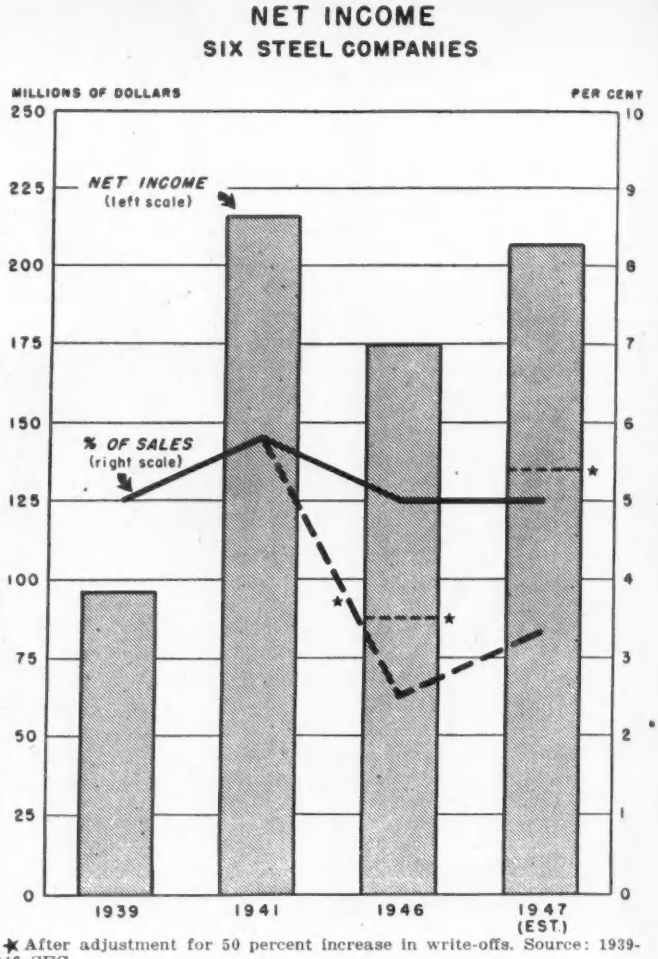


★ After adjustment for 50 percent increase in write-offs. Source: 1937-1946 Chase National Bank.

FIGURE 2

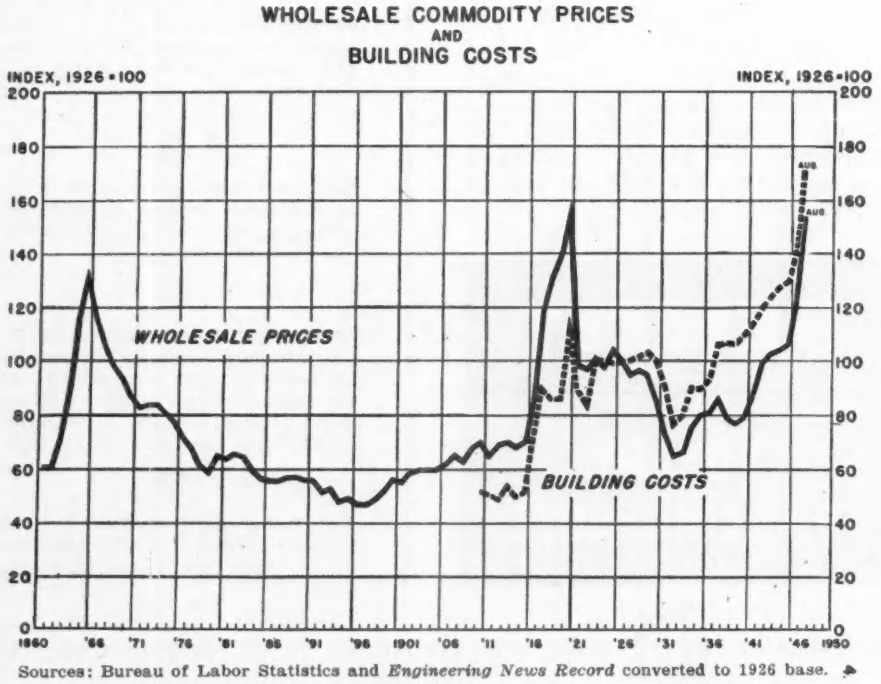


★ After adjustment for 50 percent increase in write-offs. Source: 1939-1946 SEC.

FIGURE 3

so far represented three distinct viewpoints: those of the public accountants, those of the economists, and, finally, those of management. First, the public accountant, who thrives on principles of consistency and thoroughly tested standards of procedure, staunchly defends reported earnings without any adjustment for replacement costs. He prefers to let the chips fall where they may and to offer whatever verbal explanations may be required for retaining earnings rather than distributing them. He is convinced that whatever goes up must come down, and he argues convincingly that any sound procedure for reporting excessive replacement costs should apply with equal force to declines in construction costs.

Second come the economists and others who recognize the present as a time of unprecedented inflation and who maintain that prices, profits and values should all reflect the new postwar price plateau as quickly as possible in order to avoid deceiving anyone as to actual corporate earnings. With much justification, they argue that corporate capital replenishment will span the normal business cycle without great distortion. Today, however, America has experienced



Sources: Bureau of Labor Statistics and *Engineering News Record* converted to 1926 base.

FIGURE 4

TABLE 2

Investment in Plant and Equipment Per Dollar Sales—1945

Cement	$1.89
Copper Mining	1.49
PETROLEUM	1.12
Paper	.95
Chemicals	.87
Iron and Steel	.63
Railway Equipment	.58
Textiles	.55
Autos-Trucks	.38
Machinery-Plant Equipment	.34
Electrical Equipment	.32
Locomotives	.30
Tires-Rubber	.29
Food-Meat Packing	.21

a major downward shift in the value of its currency that has penetrated the wage and price level so deeply that a complete correction is not only unlikely but highly undesirable.

And third, there is top management, stressing the immediate, practical need to state earnings in such a way that it can finance as much of its capital expenditure as possible without outside help. In this connection, seasoned observers know that prices for certain products cannot long remain at present high levels but that these same prices are now performing a vital economic funciton by diverting capital to the construction of sorely needed plants—plants which sometimes pay for themselves in a year in spite of outrageous construction costs. But what will happen when conditions return to what we call normal—say in 1950? Prices will be down, demand low, and the business manager will find himself living with fantastic depreciation on a plant which will produce at only half capacity for another 20 years.

Probable Choice of Methods

Whatever the theories that may be advanced to meet the problem, in actual practice, the method of accounting for replacement costs will probably vary from case to case. The American Institute of Accountants apparently will recommend that no profit and loss charges be established to cover replacement costs, but that some sort of surplus adjustment be made as an "appropriation" of earnings after net income has been calculated in the ordinary manner. Other concerns may set up direct charges to income, either to write off estimated "excess" costs incurred in expenditures for a single year, or to provide systematic reserves for estimated additional amounts required to replace all plant and equipment over its remaining useful life. This method provides flexibility, in that reserves so accumulated may be transferred to capital surplus if construction costs tend to remain indefinitely at present levels. Still other companies probably will refer in reports to stockholders to the estimated potential amount involved without attempting to adjust earnings.

Adjustments needed to solve problems of accounting for replacement costs will, of course, vary from industry to industry and, perhaps, even from plant to plant. On the strength of facts and figures we have reviewed here, however, it appears that the over-all problem is fully stated in the case of the petroleum industry. From the seriousness of those requirements, it is apparent that the problem demands intensive study.

Adequate Oil Prices

■ CONTINUED FROM PAGE 43

finance expansion of facilities at a cost of $85 million.

Corporate expenditures for 1947 have been estimated at about $16 billion, 2½ times normal prewar rate of capital expenditures for replacement, and of this total the petroleum industry spent one-eighth.

Garbade sees difficulties ahead for oil industry financing to care for capital needs of the order now projected. He says: "Tax rates are designed to discourage private capital accumulation and investment," and he cites mounting interest rates as a further deterrent to outside financing.

The income tax, in the belief of many economists, is becoming an instrument which is throttling free enterprise. In this respect we may take a lesson from the collapse of business in Britain. Two principal causes are often cited for the breakdown of British capitalism: British industrialists, unlike American owners, withdrew profits from their enterprises rather than reinvesting them; and Britain instituted after World War I an income tax which proved virtually confiscatory and destroyed a large sector of British economy. It is observed by many authorities that the very tax structure which proved so devastating to British industry has been gradually taken over by the American government and is now draining reservoirs of wealth that might otherwise provide new capital for expansion purposes. The soak-the-rich government policy in both Britain and the U. S. is chiefly blamed for the drying up of the most important sources of venture capital.

Venture capital historically has had one important source in wealthy individuals who were able to take a long shot chance on some industrial enterprise, such as Jim Couzens did with Henry Ford or a few backers did with the aluminum industry. In 1929 the number of individuals reporting incomes over $25,000 yearly was 103,000 and their income averaged $71,000 per taxpayer. In 1944, the number of individuals receiving a yearly income of $25,000 or more had increased to 138,000—an increase of 34 percent—but the combined earnings of all in this group were less than half what they were in 1929, after the taxes had been paid. Further, the taxpayer's average in this group had dropped from $71,000 to $24,900 after taxes. In 1929, and before, government figures show each individual in the $25,000 a year group averaged $29,000 for living expenses and invested 74 percent of the remainder in new security issues—$30,000 of venture capital. Today, however, the individual's living standard is cut from $29,000 to $24,900 initially, and he has nothing left to risk on new securities.

This is a reason why capital investment in industry has been shrinking. In 1929 investors provided $6152 in plant and tools for every factory worker in the U. S., but in 1939, only $5080. Of course the real (rather than the apparent) earnings of every worker depend on the amount of goods he produces, and this in turn depends on the capital investment in his job. Our current tax structure has not benefited the average CIO worker and other "common men" who politically supported the soak-the-rich program of the New Deal.

Some hope has been aroused lately that corporate tax reform is near so that the double tax on dividends will be eliminated. The House Ways and Means Committee apparently has been sympathetic to pleas recently that stockholders who pay tax on dividends they receive should be credited against the income tax already paid by their corporations on these earnings. The government now takes from 21 to 38 percent at corporate rates from company earnings, then taxes the individual recipient of the dividends as high as 86.45 percent of the taxpayer's dividend income.

In sum, then, the present shortage of venture capital at the time of its greatest need is the weak link in our economy, Emil Schram, president of the New York Stock Exchange, has asserted. Currently reported oil company profits are misleading. Walter S. Hallanan, president of Plymouth Oil Company, and chairman of the National Petroleum Council, says:

"In so far as domestic oil-producing companies are concerned, a very substantial portion of recently reported profits have not been actual. They show up on the books but not in the cash register. They are, in effect, a return of capital on reserves that were discovered many years ago and which can only be replaced today at a cost approximating the selling price.

"The buying power of the corporate dollar has shrunk in exactly the same proportion as the laborer's dollar and the farmer's dollar. Corporations must buy more material and services in the same inflationary market as everyone else. It must also be remembered that only through profits can American industry modernize and expand its plant structure."

Favorable Earnings Will Help Industry in Financing Expansion

By Statistical Department
Carl H. Porzheimer & Company
New York

REGARDLESS of the factors leading to the increase of 50 cents per barrel in crude oil prices in the closing month of 1947, it is becoming increasingly clear that the higher realization for crude and refined products will go far toward solving the industry's problem of financing capital expenditures required to take care of current unprecedented demands for petroleum products. Notwithstanding greatly increased profits in 1947, there has been a steadily increasing need for new funds provided through public and private borrowing and through equity financing. With capital expenditures estimated at approximately $4 billion for the next two years, the problem of raising large new amounts of capital to fiance expansion at home and abroad has naturally been a subject of serious consideration.

Over a long span of years the petroleum industry has prided itself on its ability to finance its development mainly through plowing back earnings. It was largely because of this and the absence of heavy indebtedness and senior securities that the industry was able to carry on throughout the war and to provide supplies of its products adequate to satisfy all war needs at a level of prices below that in most commodities.

With the ending of the war the petroleum industry was faced with the necessity of rehabilitating and modernizing its facilities on a vast scale. The general expectation had been that this could be done gradually during a period of temporarily slackened demand for petroleum. When, instead of a postwar decline in consumption, demand rapidly increased to a point above the peak of the war period, the industry was soon faced with needs for new facilities far beyond any previous estimates. This, combined with rising costs of materials and construction, raised the requirements for capital expenditures at a rate exceeding the gain in earnings.

There has been a steady growth of petroleum demand over the years. The oil industry has had, therefore, to spend considerably more for replacements and new facilities each year than the amounts provided through depreciation and depletion reserves from current earnings. To furnish most of the additional funds for these large capital expenditures, oil companies generally have followed the policy of distributing in dividends only about half their reported net earnings and retaining the balance to finance expansion. As a consequence, only about 15 percent of the capital employed by the industry has been represented by borrowed funds.

Confronted with a tremendous expansion program at a time of inflated costs, the industry has been faced with the alternative of providing an even larger part of capital requirements from earnings or resorting to outside sources on an increasingly greater scale. Higher earnings at this time will enable the industry to continue following the more desirable alternative of financing the major part of its expansion with funds derived from its own operations. Furthermore, those companies finding it necessary to raise new capital will be able to do so advantageously because of their favorable earnings prospects.

The record rate at which new petroleum consuming units have come into use has resulted in steadily mounting consumption of oil products. While the industry has increased its output to new high levels, its ability to expand producing, refining and transportation facilities has been limited by steel and other materials shortages so that supply has lagged behind the growth in demand and the industry has been finding it difficult to meet all requirements.

The great expansion in consumption of distillate oils, including diesel fuels, used in heating homes and for railroad, truck and bus transportation, and in mechanized farm equipment, has created the greatest problem for the industry in balancing current supply and demand. This is clearly shown by Table 1. It will be seen that while total petroleum demand in 1947 was 9.8 percent greater than in 1946 and 33.7 percent greater than in 1941, the gains for distillate fuels in 1947 were 17.6 percent over 1946 and 68.8 percent greater than in 1941.

The heavy demand for oil in combination with higher crude and refined product prices has been reflected in average increases of approximately 60 percent in 1947 oil company earnings and 40 percent in aggregate dividend disbursements. With prices at the start of the new year about 36 percent higher than the 1947 average and forecasts of petroleum demand increases ranging around 6 percent for 1948, the outlook is for a further substantial rise in earnings.

During 1947, average crude oil prices were raised 25 cents per barrel March 10, 20 cents per barrel October 15, and 50 cents per barrel December 6, bringing the price of 36-gravity Mid-Continent crude to $2.57 per barrel. Refined product prices were generally raised to reflect the higher crude prices. Despite these increases, the price level for petroleum products has risen considerably less than the average of all commodities. The U. S. Department of Labor's wholesale commodity price index (using 1926 as 100) averaged 159.5 for November, 1947, an increase of 59.5 percent since 1926, while the November petroleum price index was 99.9, or about the same as the 1926 level. It was estimated that the December oil price increases will add about ten points to the petroleum price index.

The relative effect of the higher crude oil prices on 1948 per share earnings of the various oil companies together with estimates of earnings for the year 1947 is shown in Table 2. The current crude price level is 68 cents per barrel higher than the average for the year 1947. It is estimated that approximately half of the increased revenues resulting from the higher crude prices will be carried down

TABLE 1
Total Domestic and Export Demand
(Thousands of Barrels)

	Motor Fuel	Residual Fuel Oil	Distillate Fuel Oil	Kerosene	All Oils
*1947	835,400	524,000	320,200	108,400	2,132,500
1946	780,222	485,430	272,318	97,725	1,942,200
1945	784,392	536,703	259,580	81,753	1,952,140
1944	733,019	525,721	252,811	76,700	1,878,879
1943	619,815	484,478	233,067	73,350	1,671,383
1942	624,207	417,106	207,236	72,343	1,566,815
1941	694,588	399,263	189,749	72,690	1,594,609
1940	614,867	357,696	179,991	72,150	1,457,086
1939	600,147	344,110	166,993	68,744	1,420,035
1938	573,112	307,791	147,090	63,864	1,330,850

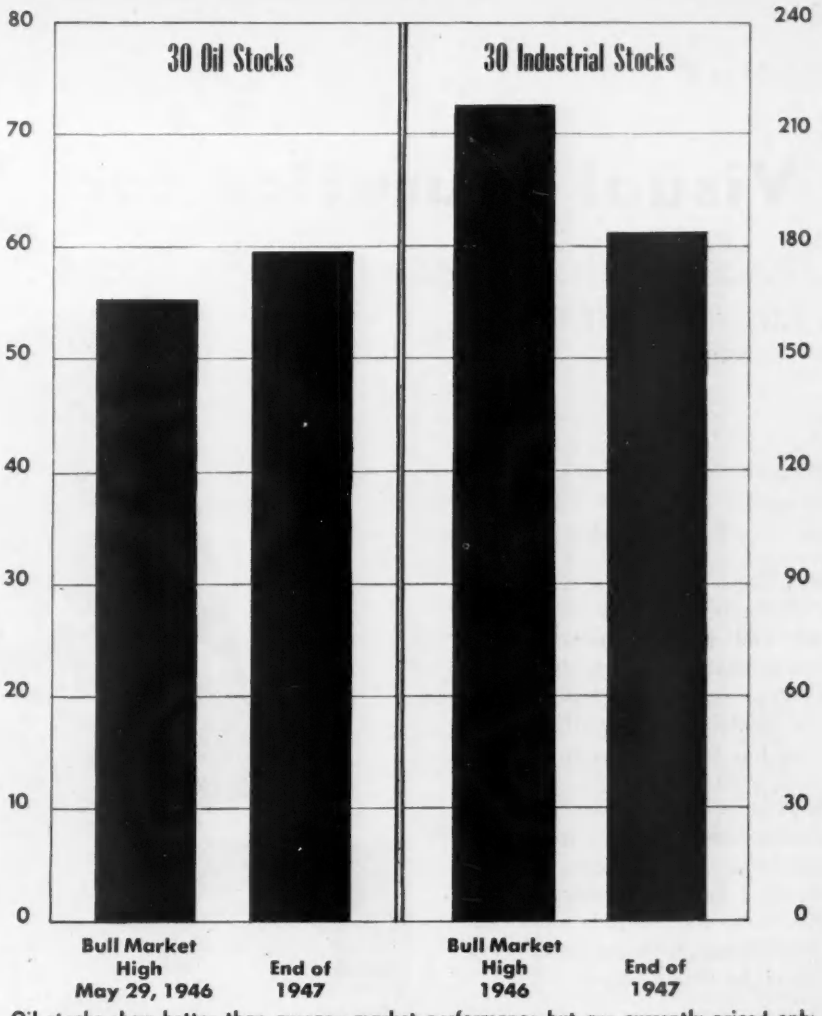
* Estimated by the U. S. Bureau of Mines.

to net income. About 30 percent will be absorbed by income taxes after allowing for statutory depletion and an additional 20 percent will be taken by depreciation, production taxes and higher costs. Production rates for 1946 have been used as the basis for these computations, as they are the latest complete figures available. Most companies, however, have shown increases in production since 1946 and these gains will go far toward offsetting any additional rise in costs.

In estimating the effect of higher crude prices, no adjustment has been made for the varying degree of integration of the different companies (also shown in the table) as refined product prices have been adjusted upward in line with the increase in crude prices. While no attempt has been made to estimate the effect of refined product price increases on refining and marketing operations of the integrated companies, it should be borne in mind that these companies could also realize additional profits from greater volumes. Thus it has been assumed that the crude price increase will be realized on a company's entire production without any deduction for increased cost of crude oil purchased to meet refinery requirements in excess of own production.

Whereas there has been considerable discussion of the effect of crude price increases on oil company earnings, relatively less attention has been paid to the tremendous increase that has taken place in the value of proved crude oil reserves and this does not seem to be fully reflected in the market for oil equities. It is conservatively estimated that most of the leading oil companies have crude oil reserves equal to about two barrels for each dollar of stock market value. Prior to April 1, 1946, when crude oil was selling at $1.17 per barrel, proven reserves were generally appraised at values ranging up to 50 cents per barrel. Subsequent increases in crude prices totaling $1.40 per barrel, after allowing for increased costs, are estimated to have resulted in more than doubling the value of proved reserves which are now being valued at $1 or more per barrel. Many industry officials contend that for the first time in many years the current price more nearly reflects replacement costs.

Our average of 30 oil stocks closed the year at 59.53, surpassing by 7.5 percent the bull market high of 55.35 established May 29, 1946. In comparison the Dow-Jones average of 30 industrial stocks on December 31, 1947, closed at 181.16, or 14.7 percent under the 1946 high of 212.50. Despite their better-than-average market performance in 1947, oil stocks are currently selling at only 7.5 times estimated 1947 per share earnings. This compares with an average annual ratio of 11.5 for the years since 1937.



Oil stocks show better than average market performance but are currently priced only 7.5 times earnings (for explanation of chart see last paragraph of text).

TABLE 2

Estimated Effect of 1947 Crude Oil Price Increases on Per Share Earnings of Leading Oil Companies

	Net Crude Oil Production Per Share Bbls. 1946	Crude Oil Refined Per Share Bbls. 1946	Estimated Net Income Per Share 1947*	Estimated Per Share Net Effect of Increased Crude Prices†
Amerada Petroleum	11.5	.....	$9.35	$3.91
Atlantic Refining	8.8	16.7	5.25	2.99
Barnsdall Oil	4.4	.....	4.10	1.50
Continental Oil	7.4	4.7	7.25	2.52
Creole Petroleum	6.4	0.9	5.00	2.18
Deep Rock Oil	7.2	11.0	6.50	2.45
Gulf Oil	13.9(a)	13.8	10.00	4.73
Houston Oil	3.1	.....	3.25	1.05
Humble Oil	6.3	4.1	7.00	2.14
Lion Oil	3.1	5.1	5.75	1.05
Mid-Continent Pet.	3.6	6.8	8.90	1.22
Ohio Oil	4.8	1.1	4.75	1.63
Phillips Petroleum	5.6	4.9	6.50(g)	1.90
Plymouth Oil	4.3	.....	3.50	1.46
Pure Oil	7.0	8.2	4.50	2.38
Richfield Oil	2.2	6.1	2.75	0.75
Seaboard Oil	6.3	.....	4.50	2.14
Shell Union	4.8	7.4	4.25	1.63
Sinclair Oil	2.2(b)	7.7	3.50	0.75
Skelly Oil	13.8	10.8	19.00	4.69
Socony-Vacuum	1.9(c)	4.8	3.25	0.65
S. O. California	6.1(d)	6.8	8.00	2.07
S. O. Indiana	4.2	8.1	6.00	1.43
S. O. New Jersey	12.2(e)	16.6	10.50	4.15
S. O. Ohio	2.6	8.7	4.25(g)	0.88
Sun Oil	7.0	14.0	5.75	2.38
Superior Oil (Calif.)	39.2	.....	11.51(h)	13.33
Texas Comapny	6.3(f)	9.9	7.75(g)	2.14
Texas Pacific	4.9	.....	4.50	1.67
Tide Water Associated	4.9	9.2	4.00	1.67
Union Oil of Calif.	5.5	7.3	4.00	1.87

* Before special reserves. † Based on assumption that half of the increase in crude prices over the 1947 average will be carried down to net income—see text. (a) Domestic 8.3 bbls.; Venezuelan 5.6 bbls.; half interest in Kuwait production not included. (b) Does not include 0.8 bbl. per share interest in Venezuela production of unconsolidated subsidiary. (c) Does not include 0.5 bbl. per share interest in production in Venezuela, Colombia and Iraq. (d) Does not include half interest in 1946 production in Saudi-Arabia and Bahrein Island equal to 2.6 bbls. per share. (e) Domestic 4.9 bbls.; foreign 7.3 bbls. mainly Venezuela—Deducting minority interest in subsidiaries would reduce total to about 10.5 bbls. per share. (f) Does not include half interest in 1946 production in Arabia and Bahrein equal to 2.5 bbls. per share. (g) On increased number of shares. (h) Official for year ended August 31, 1947.

Visual Education for Safety

By ANTHONY GIBBON
Staff Writer

FOLLOWING a comparatively new trend in safety promotion techniques, Stanolind Oil & Gas Company, Tulsa, has completed a sound slide film showing several phases of well servicing, including the pulling of rods and tubing, swabbing, and paraffin removal. The color film is designed primarily to emphasize correct operational methods that insure the safety of men on the job.

The film has been shown to most of Stanolind's 4500 supervisors and field workers in all of the company's operating divisions, and although no figures are available as a comparison with results obtained through standard safety instruction methods, company safety experts and officials believe the effort is paying good dividends in lower accident frequency.

The film has been prepared so to emphasize the following fundamental safety principles:

A. Good job planning and supervision.
B. Safe construction.
C. Good tools and equipment.
D. Adequate safeguards for the job.

The film consists of 92 pictures or frames and runs 20 minutes. It is shown at convenient points on the job during working hours. Safety experts with Stanolind and other companies who have

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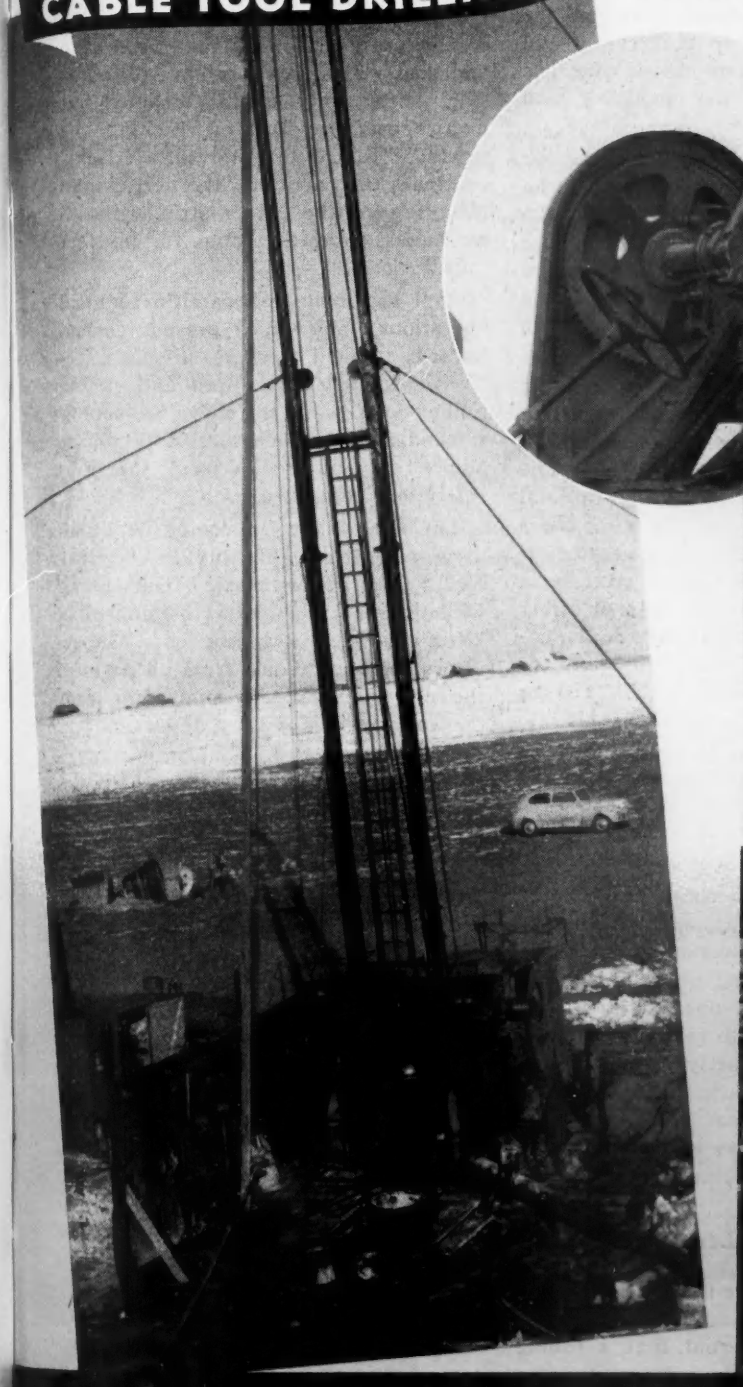
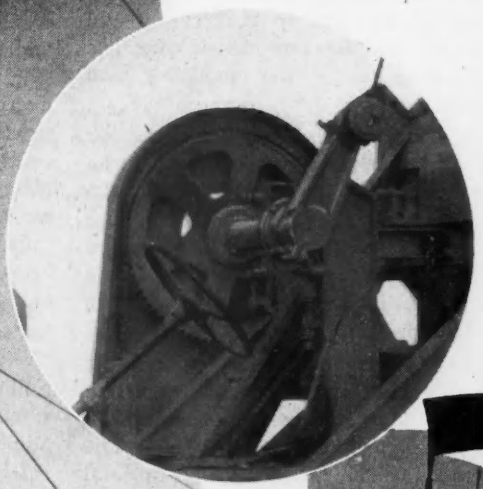
Mobilhoist with 55-foot double leg mast "drilling-in" a rotary drilled well with cable tools.

CABLE TOOL DRILLING

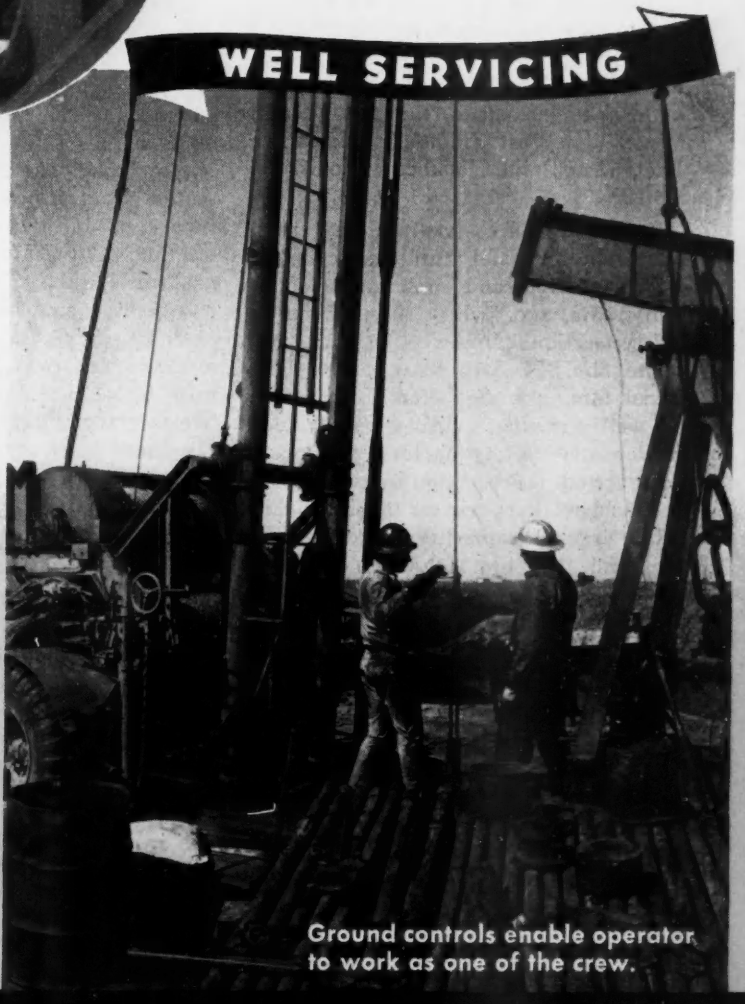


Spudding assembly for all cable tool operations.



Here's the rig that has everything! Self-propelled with top road speed of 35 m.p.h. Heavy-duty special Timken-built rear axle and spiral bevel gear drive. Drums have five even-step speeds and one reverse. Rotary and spudding assemblies are interchangeable in the field. Mast is carried on mobilhoist with lines and block reeved. Recommended for servicing to 4,000 feet; 2,000-foot drilling with 3½" drill pipe, or cable tools to 3,800 feet.

WELL SERVICING



Ground controls enable operator to work as one of the crew.

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evaluated the results are convinced that it has marked advantages over conventional safety classes where safety representatives and supervisors use only the oral and diagrammatic method of instruction in safety practices and techniques.

The well-servicing film is Stanolind's second venture in the visual education for safety, and officials of the company are so impressed with the reception given the picture by supervisors and field workers that the safety program may shortly be expanded to include other films portraying distinct operations in drilling, production, exploration, manufacturing and research. The safety section has ben instructed to undertake an intensive study of the new visual technique, which may become an integral part of the industry's safety program.

Four Sections

Credit for the preparation and filming of this second Stanolind film goes to William B. Cox of Houston, division safety supervisor for the Gulf Coast division, who visited many of the company's operations in order to get the 92 pictures. The film is divided into four sections and shows crews engaged in rod pulling, tubing pulling, well swabbing and paraffin scraping. Each section of the film has a different locale, with shots taken in the Salt Creek, Wyoming, West Edmond, Oklahoma, East Texas, and Hackberry Louisiana, fields.

Stanolind's first venture in visual education for safety utilizing celluloid was conceived and undertaken about two years ago, when the company's safety section completed a black and white film, "A Trip to the Rig." The initial film, like the companion picture on well servicing, emphasized the four fundamental safety factors previously enumerated. Its reception by supervisors and field workers was so favorable that safety experts realized they had a potent tool and that the technique of visual education to expedite safety had decided advantages over the standard oral and diagrammatic methods.

As one safety expert declared: "The men get a kick out of a picture which they cannot possibly get in the course of a regular safety instruction class. For one thing, it is new and novel. It instills additional interest in the supervisors and teaches them to be more explicit on the job in instructing their men in safe working methods. Field workers will turn out for a picture where they might be inclined to pass up an instruction class."

Besides its instructive value, "Oil Well Servicing" is entertaining, with excellent color effects and effective dialogue. Close attention was given to the preparation of the dialogue. It was carefully written and reviewed, and the final sound track results in a narrative which achieves clarity of thought and expression and carries a psychological punch.

Following the title, the picture opens with a brief recital of the story of the men who keep the wells pumping—the story of oil well servicing from the Rocky Mountains to the Gulf of Mexico; the story of oil field roustabouts that do the well servicing, and the tools they use to do the job safely.

The narrator describes how the individual job is laid out, pointing out that supervisors have already studied the history of the well to be serviced and have informed the crew as to what has to be done to the well and how, and why.

"A good supervisor does the job twice," the narrator continues. "First he does his job in his mind and then he does it on the job. He also makes sure that each man under his supervision thoroughly understands his part of the job. Good job planning is a must in accident prevention."

Shot after shot flashes across the screen, each emphasizing an important point in safety. A picture of a derrickman (perhaps the derickman shown is among the audience) putting on and adjusting his safety belt is more effective and likely to command greater attention than an oral caution given by a supervisor during a conventional safety meeting. While the audience is engrossed in the picture the narrator drives his point home with: "To the derrickman, his safety belt is his life line and he always puts on and carefully adjusts this piece of equipment before starting his job. He inspects it. He keeps it clean. He protects it and then he knows that it will protect him."

Approximately 40 shots are devoted to rod pulling operations as the narrator stresses the importance of properly anchoring the pulling unit, care in rigging blocks so that operator and crew may continue the job in a safe manner, the need for properly synchronizing each operation so as to insure a smooth working rhythm that makes for safe and efficient work, as well as other important safety precautions and practices.

Safety Lessons

About 15 shots are used in connection with the tubing pulling operation, while the narrator points out that a tubing pulling job, similar in some respects to the rod job, requires heavier equipment and a larger crew but also requires the same careful planning. Workers are cautioned on the need for assuring that personal protective equipment, including hard hats, safety shoes and gloves are always available and in good condition.

"The unit operator is responsible for the safety of the entire crew, and he must be alert to any emergency that might arise," the narrator declares. "When pulling a wet string or if the tubing is rusty or the well has been treated with some chemical, goggles are necessary for eye protection for all floormen.

"Although the temptation may be great, the derrickman always uses the ladder and never rides the traveling blocks or slides down the tubing." (This is always good for a laugh from the audience, many of whom have on occasion, been guilty of this snappy but dangerous method of reaching the ground. "In climbing up the derrick," continues the narrator, "the derrickman always grips the ladder stringers with his hands, using the rungs for his feet only."

Well swabbing and paraffin removal operations, jobs which present certain hazards to field workers, are as effectively depicted as the rod and tubing pulling jobs, while the slides are soundtracked with the same clear and concise advice on how to perform the jobs safely and efficiently.

The finale shows a composite of all divisions—Rocky Mountain, Central, North Texas-New Moxico, Gulf Coast while the narrator tells the audience: "You have seen how experienced supervisors and roustabouts from all parts of the oil country expertly and safely carry out various jobs of oil well servicing.

"You have seen the man in his safety hat. You know that goggles save eyes, and that safety shoes protects the workman's toes (pictures showing men wearing appropriate safety accessories.

"Therefore, whether it is a rod job, a tubing job, a swabbing job or a paraffin scraping job, proper job planning and good supervision, safe construction, good tools and equipment and adequate safeguards are fundamentals that are common to all good well servicing operations wherever they are performed."

To the safety man as well as to the man in the field, this is old stuff, but it is being presented in a new and interesting package. Instead of a chore to be ducked, visual education for safety is novel entertainment and is fast gaining recognition.

Stanolind has six prints of "Oil Well Servicing" that are available to operators. A request to the company's safety section in any division will obtain the loan of a film.

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of formation characteristics and locations

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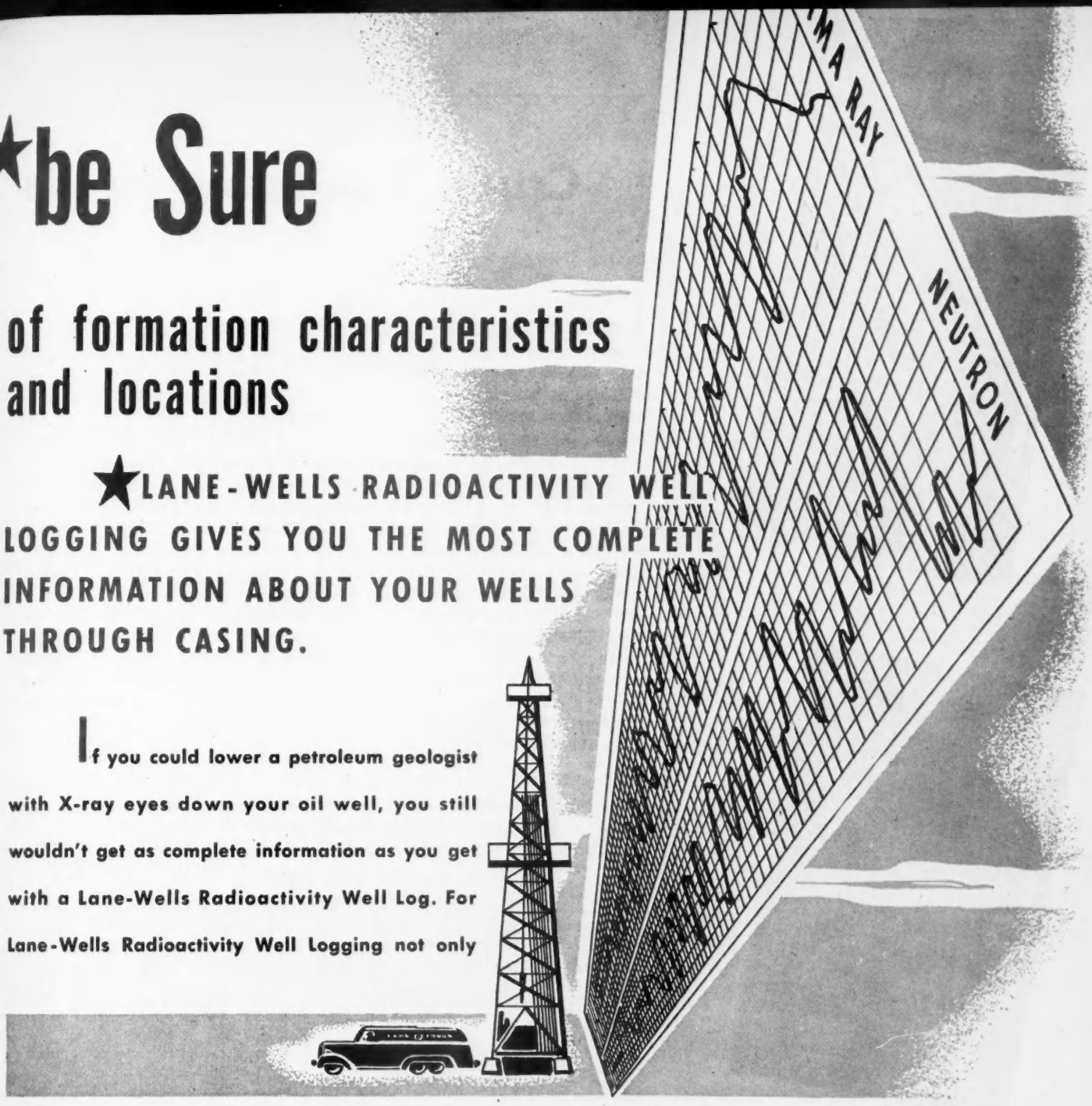

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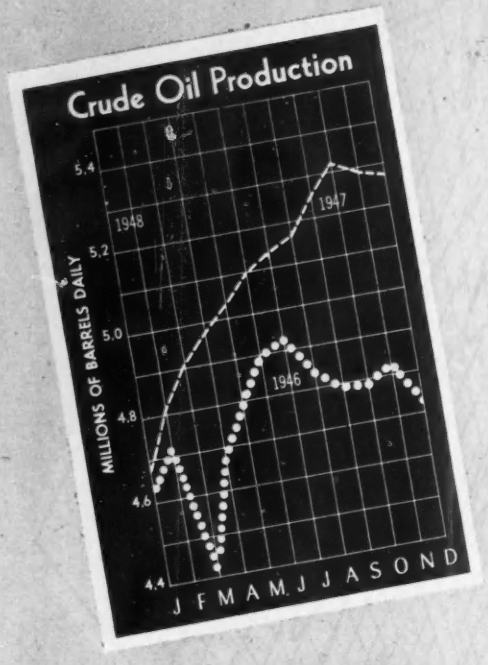
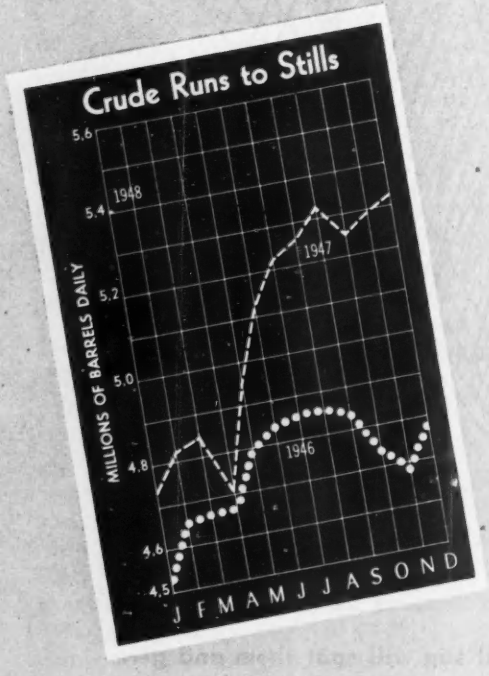
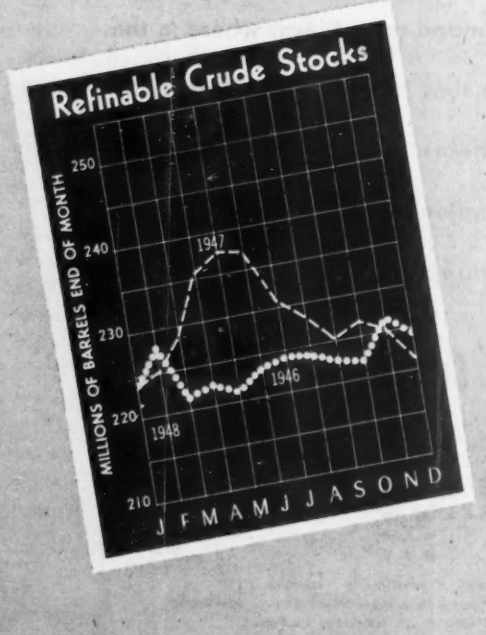
Crude Processing Holds

By CECIL SMITH







JANUARY was the eighth consecutive month in which the U. S. petroleum industry produced and refined more than 5 million barrels of crude daily. These levels were hardly thought to be attainable a few years ago and even global warfare, in which the industry and its products played such an important role, failed to make them necessary.

But today, with so many of the nation's domestic and industrial fuel consumers having become awakened to the desirability of oil as a fuel, the facilities to produce and distribute these products have been overtaxed—overtaxed because this tremendously increased demand was dumped into the industry's lap with facilities that had been adequate for prewar needs, but which had been badly depreciated through heavy use and lack of proper replacement and modernization during the war. Had this demand upsurge been gradual and had there been ample supplies of steel, the industry would have kept pace and today's fuel shortages would be non-existent. But the steel industry has been faced with the same difficulties. It, too, fought the war during which its expansion was also limited and now finds itself faced with the same postwar increases for its products. These industries have done and will continue to do remarkable jobs in the face of mounting odds as long as they are allowed to remain competitive and free to exercise individual initiative.

Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month
1945:									
January	4,756	4,680	221,737	2,094	91,666	663	31,695	1,350	44,347
February	4,767	4,817	220,221	2,194	97,457	724	27,210	1,326	39,760
March	4,804	4,719	223,988	2,124	97,447	675	26,729	1,273	35,451
April	4,807	4,774	224,229	2,127	90,804	681	29,148	1,289	34,418
May	4,887	4,913	223,151	2,179	88,530	708	29,511	1,341	34,333
June	4,859	4,989	218,218	2,166	86,128	730	32,440	1,351	35,606
July	4,897	5,001	216,638	2,281	85,582	713	36,276	1,351	38,341
August	4,870	4,928	215,135	2,269	84,003	701	41,245	1,329	42,227
September	4,423	4,275	220,319	1,933	74,574	640	45,059	1,139	42,822
October	4,284	4,244	221,246	1,888	76,805	613	45,479	1,176	42,068
November	4,517	4,624	218,916	2,156	86,540	665	44,562	1,265	41,322
December	4,472	4,574	218,763	2,056	97,676	683	35,778	1,245	37,158
1946:									
January	4,625	4,520	223,442	1,914	102,394	787	28,990	1,224	34,573
February	4,719	4,651	227,220	1,884	104,836	823	25,511	1,243	34,008
March	4,414	4,661	221,400	1,900	104,161	816	29,922	1,213	32,995
April	4,673	4,663	222,480	1,943	98,744	773	32,064	1,247	35,206
May	4,785	4,794	221,592	2,016	93,960	753	33,385	1,220	38,932
June	4,896	4,836	223,140	2,055	91,971	777	38,824	1,219	41,492
July	4,922	4,856	224,351	2,102	87,778	793	46,439	1,163	45,446
August	4,836	4,856	224,157	2,189	86,745	765	54,068	1,159	48,186
September	4,790	4,839	222,417	2,143	87,021	796	62,019	1,150	54,012
October	4,785	4,736	222,177	2,117	85,952	788	76,780	1,090	55,580
November	4,823	4,684	226,453	2,162	88,587	791	68,145	1,101	52,735
December	4,725	4,780	224,473	2,168	92,742	805	59,912	1,159	47,094
1947:									
January	4,671	4,739	223,848	2,078	99,623	778	48,197	1,174	41,550
February	4,810	4,820	225,121	2,089	103,672	777	36,901	1,228	48,480
March	4,908	4,843	228,981	2,076	105,679	825	31,423	1,222	37,403
April	4,974	4,707	235,710	2,037	101,724	764	30,268	1,148	36,455
May	5,033	4,947	237,768	2,128	95,209	805	34,279	1,204	39,992
June	5,099	5,120	237,278	2,258	89,774	807	39,676	1,233	43,515
July	5,137	5,221	230,974	2,302	86,003	847	46,444	1,244	47,600
August	5,173	5,260	228,523	2,383	85,849	869	54,707	1,245	51,334
September	5,251	5,236	225,258	2,375	84,360	911	59,764	1,237	52,578
October	5,320	5,253	226,666	2,371	82,584	938	63,252	1,260	52,502
November	5,291	5,291	225,462	2,332	87,551	942	61,334	1,245	52,455
December	5,274	5,324	221,319	2,329	92,886	952	50,161	1,289	45,547
1948:									
January	5,321	5,403	221,663	2,342	102,973	1,082	40,580	1,290	44,419
January, 1948 Changes:									
In Month	+47	+79	+344	+13	+10,087	+130	−9,581	+1	−1,128
In One Year	+650	+664	−2,185	+264	+3,350	+304	−7,617	+116	+2,869
In Two Years	+696	+883	−1,779	+428	+579	+295	+11,590	+66	+9,846

Trends

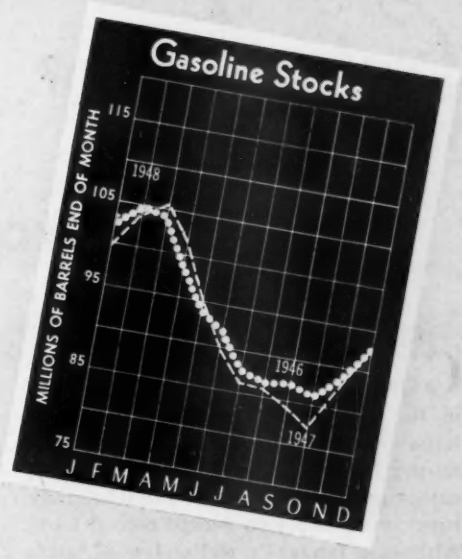
5-Million Barrel Level

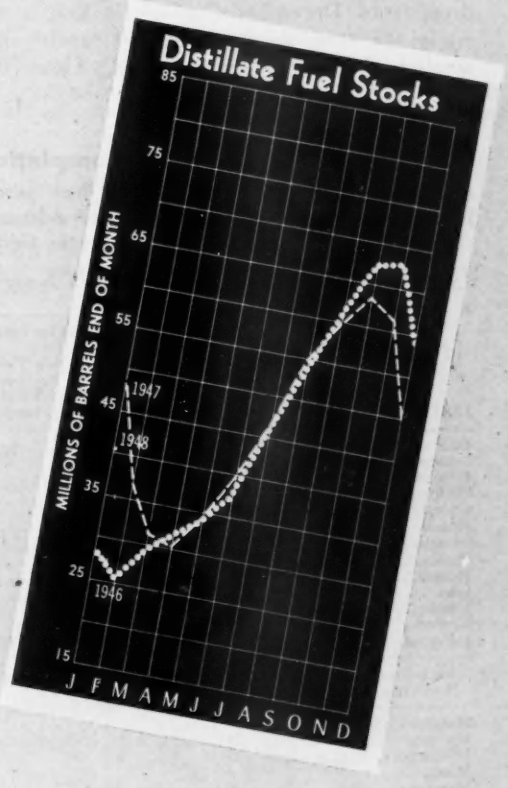
Staff Writer

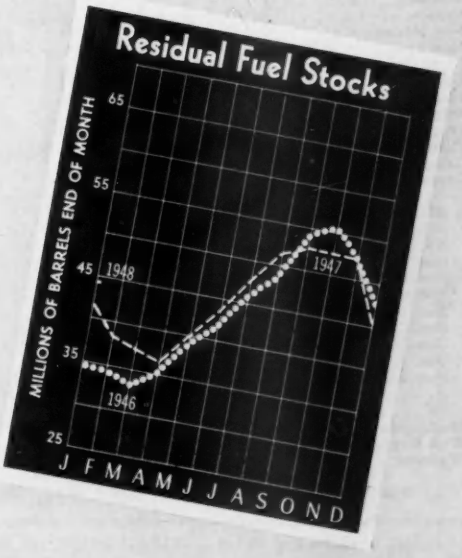
Because of the pressing need for its products, which is presently fuel oils and in a few months will be motor fuels, the petroleum industry boosted its operations to still higher levels during January. All-time record highs were set in both production and processing of crude oil. U. S. crude production averaged 5,321,000 barrels daily, the highest ever recorded. It had been almost that high once before, that being in October, 1947, when output hit 5,320,000 daily. January's daily output was 1,758,000 barrels over that produced per day in the same month of the last prewar year, 1941, and back in those days stocks of crude had been able to stand at about 244 million barrels, while today they total just over 221 million and unable to do much climbing.

Daily runs to refinery stills during the month amounted to 5,403,000 barrels or 79,000 barrels more than were run during the peak month of December. Based on the API's latest figure for the nation's rated refining capacity, January's refinery operations utilized 94.4 percent of that total capacity. That high rate of operation over a period of time was almost unthought of a few years back, but has become the rule during the last six months.

Production of domestic heating oils hit a new peak during the month, amounting to 1,082,000 barrels daily. A month before it had been 130,000 barrels less and 304,000 a day less a year before. Stocks of these domestic fuels were lowered by 9,581,000 barrels during the month and ended totaling 40,580,000 barrels. That amount was 7,617,000 barrels less than was on hand a year ago. Despite rigorous January weather in parts of the country, this record fuel oil production resulted in stocks holding up surprisingly well.







State Crude Oil Production

(THOUSANDS OF BARRELS)

STATE OR DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL PRODUCTION		
	January, 1948	December, 1947	January, 1947	% Diff. January, '47-'48	January, 1948	January, 1947	% Diff. January, '47-'48
Alabama	1.3	1.3	1.0	+ 30.0	40	31	+ 30.0
Arkansas	81.0	80.1	79.1	+ 2.4	2,510	2,452	+ 2.4
California	931.0	927.3	884.2	+ 5.3	28,861	27,409	+ 5.3
Colorado	45.5	46.0	37.5	+ 21.3	1,411	1,164	+ 21.3
Florida	0.8	0.7	0.2	+300.0	25	7	+300.0
Illinois	171.0	176.9	193.1	— 11.4	5,301	5,985	— 11.4
Indiana	17.7	18.2	17.3	+ 2.3	550	538	+ 2.3
Kansas	289.2	284.4	269.2	+ 7.4	8,966	8,346	+ 7.4
Kentucky	26.6	27.8	25.8	+ 3.1	824	800	+ 3.1
Louisiana	460.7	453.2	414.4	+ 11.2	14,281	12,847	+ 11.2
North Louisiana	107.2	108.2	93.4	+ 14.8	3,322	2,896	+ 14.8
South Louisiana	353.5	345.0	321.0	+ 10.1	10,959	9,951	+ 10.1
Michigan	46.9	48.5	42.7	+ 9.8	1,453	1,322	+ 9.8
Mississippi	114.8	111.1	87.7	+ 30.9	3,560	2,720	+ 30.9
Missouri	0.2	0.2	0.2	.....	4	4	.....
Montana	24.5	24.8	22.3	+ 9.9	760	691	+ 9.9
Nebraska	0.5	0.5	0.7	— 28.6	16	23	— 28.6
New Mexico	123.4	120.4	101.8	+ 21.2	3,824	3,156	+ 21.2
New York	13.9	13.2	13.5	+ 3.0	430	419	+ 3.0
Ohio	8.3	8.8	7.6	+ 9.2	259	236	+ 9.2
Oklahoma	406.5	410.4	363.6	+ 11.8	12,601	11,272	+ 11.8
Pennsylvania	32.7	31.8	35.8	— 8.7	1,014	1,110	— 8.7
Tennessee	.....	.....	.....	.....	1	1	.....
Texas	2,383.7	2,348.6	1,958.2	+ 21.7	73,893	60,703	+ 21.7
Dist. 1: South Central	25.6	24.9	19.1	+ 34.0	792	591	+ 34.0
Dist. 2: Middle Gulf	168.1	163.8	133.2	+ 26.2	5,211	4,130	+ 26.2
Dist. 3: Upper Gulf	496.3	488.0	412.9	+ 20.2	15,384	12,801	+ 20.2
Dist. 4: Lower Gulf-S.W.	255.6	258.0	206.7	+ 23.7	7,925	6,407	+ 23.7
Dist. 5: East Central	44.0	42.3	33.8	+ 30.2	1,366	1,047	+ 30.2
Dist. 6: Northeast	415.3	413.6	401.6	+ 3.4	12,874	12,448	+ 3.4
Dist. 7-B: N. Central	42.9	42.1	34.0	+ 26.2	1,330	1,055	+ 26.2
Dist. 7-C: W. Central	42.8	41.4	27.6	+ 55.1	1,326	856	+ 55.1
Dist. 8: West	658.7	648.7	467.3	+ 41.0	20,419	14,486	+ 41.0
Dist. 9: North	142.4	136.6	118.2	+ 20.5	4,413	3,665	+ 20.5
Dist. 10: Panhandle	92.0	89.2	82.0	+ 12.2	2,853	2,541	+ 12.2
Virginia	.....	.....	0.3	— 87.5	1	8	— 87.5
West Virginia	6.8	6.9	7.3	— 6.8	211	227	— 6.8
Wyoming	133.5	133.0	107.4	+ 24.3	4,139	3,329	+ 24.3
Total United States	5,320.5	5,274.1	4,670.9	+ 13.9	164,935	144,800	+ 13.9

Completions

Off to Fast Start

CONTINUED high drilling activity in the U. S. resulted in an unusually large number of wells being completed during January to give the 1948 drilling campaign a running start on what may turn out to be a new record record high. Although January's wells showed some drop from December's, which is generally the case, the decrease was much smaller than in previous years. This could be the tipoff that this year might top the all-time high of about 35,000 completions made in 1937. January's wells were not only higher than the average during last year, but were at a point that was not reached until July of that year. However, records for next month probably will show that this high drilling rate was impossible to maintain during February, as cold and wet weather in some regions is causing more and more operations to be shut down or postponed.

During January there were 2955 wells completed, while December's records showed 3033 completions. Although this decrease followed the normal seasonal trend, it was less pronounced than in past years. This was mainly due to the weather permitting activity to remain high through January, but it is believed that the advent of severe winter conditions will be reflected by a drop in February's well completions. Regardless of what caused or allowed January's drilling tempo, the fact remains that it resulted in completion of 30.5 percent more wells than in last year's initial month. In the future this month will not stand alone in the increased drilling column, for the industry will continue to use its every faculty to drill as many wells and produce as much oil as weather and materials will permit.

Well Completions in the United States During January, 1948

(Figures compiled by WORLD OIL staff from private reports and other sources as follows: Illinois from Illinois Geological Survey; Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon, and Allegany fields of Pennsylvania and New York from *The Producers' Monthly*)

STATE OR DISTRICT	MONTHLY COMPLETIONS: Details for January, 1948: New Wells: Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New	Total Completions: Total Drilled Deeper	Jan., 1948	Dec., 1947	Jan., 1947	Percent Difference from Year Ago	Total Footage January, 1948	Rigs in Operation: Jan. 31, 1948	Dec. 31, 1947	Jan. 31 1947
Alabama	....	....	....	1	....	....	....	1	....	1	4	....	.....	9,008	1	2	7
Arizona	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	1	1	....
Arkansas	16	....	1	13	....	....	....	30	1	31	28	17	+ 82.4	116,421	35	40	35
California	192	....	1	27	....	....	....	220	....	220	176	149	+ 47.7	759,881	293	275	293
Colorado	20	....	....	7	....	....	....	27	....	27	20	9	+200.0	140,238	59	63	54
Florida	1	....	....	2	....	....	....	3	....	3	1	3	.....	28,982	4	4	10
Georgia	....	....	....	....	....	....	....	....	....	....	1	....	.....	.....	....	....	1
Illinois	85	....	....	60	....	....	....	145	....	145	160	147	— 1.4	365,280	203	214	232
Indiana	44	....	2	38	....	....	2	86	....	86	76	34	+152.9	169,497	64	66	63
Iowa	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	....	....	1
Kansas	113	....	22	72	....	....	1	208	....	208	278	171	+ 21.6	701,925	321	338	356
Kentucky	20	....	24	21	....	....	....	65	....	65	72	56	+ 16.1	132,817	70	75	96
Louisiana	85	8	13	39	....	....	....	145	....	145	166	110	+ 31.8	768,642	196	195	145
North Louisiana	48	1	11	18	....	....	....	78	....	78	124	55	+ 41.8	192,942	60	69	51
South Louisiana	37	7	2	21	....	....	....	67	....	67	42	55	+ 21.8	575,700	136	126	94
Maryland	....	....	....	1	....	....	....	1	....	1	....	....	.....	5,259	....	1	....
Michigan	24	....	6	27	....	....	....	57	....	57	56	40	+ 42.5	129,017	96	118	105
Mississippi	15	2	1	18	....	....	....	36	....	36	33	26	+ 38.5	310,136	52	58	60
Missouri	....	....	....	....	....	....	....	....	....	....	6	10	.....	.....	5	3	1
Montana	20	....	....	7	....	....	....	27	1	28	25	9	+211.1	81,060	62	61	43
Nebraska	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	1	1	2
Nevada	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	1	....	....
New Mexico	40	....	3	8	....	....	....	51	5	56	73	42	+ 33.3	212,304	108	106	102
New York	89	....	1	....	55	....	....	145	....	145	172	108	+ 34.3	203,226	184	204	102
North Carolina	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	....	....	1
Ohio	27	....	32	31	....	....	....	90	1	91	107	121	— 24.8	274,182	211	223	239
Oklahoma	185	2	15	141	....	....	....	343	12	355	360	271	+ 31.0	1,209,068	541	544	502
Oregon	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	....	....	....
Pennsylvania	95	....	46	20	77	24	....	262	4	266	276	275	— 3.3	457,635	368	449	365
South Dakota	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	1	1	1
Tennessee	1	....	....	2	....	....	....	3	....	3	4	....	.....	6,177	19	19	10
Texas	493	18	34	308	....	....	....	853	18	871	828	584	+ 49.1	3,735,735	1,290	1,361	1,133
Dist. 1: S. Central	21	....	1	17	....	....	....	39	1	40	28	22	+ 81.8	120,229	50	59	32
Dist. 2: Middle Gulf	30	8	2	29	....	....	....	69	2	71	56	39	+ 82.1	406,151	55	67	[1]
Dist. 3: Upper Gulf	34	6	4	33	....	....	....	77	....	77	85	60	+ 28.3	518,042	113	127	77
Dist. 4: L. Gulf-S.W.	52	3	4	40	....	....	....	99	5	104	108	63	+ 65.1	510,406	116	124	133
Dist. 5: E. Central	3	....	1	12	....	....	....	16	....	16	15	9	+ 77.8	64,441	33	30	[2]
Dist. 6: Northeast	22	1	4	12	....	....	....	39	....	39	32	38	+ 2.6	210,276	50	58	89
Dist. 7-B: N. Central	38	....	....	51	....	....	....	89	4	93	95	54	+ 72.2	260,377	124	125	[3]
Dist. 7-C: W. Central	20	....	....	8	....	....	....	28	....	28	19	7	+300.0	115,081	62	65	[4]
Dist. 8: West	168	....	1	26	....	....	....	195	4	199	171	127	+ 56.7	928,722	443	460	495
Dist. 9: North	80	....	1	76	....	....	....	157	2	159	150	129	+ 23.3	467,722	115	116	201
Dist. 10: Panhandle	25	....	16	4	....	....	....	45	....	45	69	36	+ 25.0	134,288	129	130	106
Utah	....	....	....	2	....	....	....	2	....	2	....	....	.....	1,537	14	15	5
Washington	....	....	....	....	....	....	....	....	....	....	....	....	.....	.....	1	1	1
West Virginia	9	....	52	13	....	1	....	75	2	77	80	62	+ 24.2	179,424	365	384	372
Wyoming	28	....	1	6	....	....	....	35	1	36	31	20	+ 80.0	146,020	84	79	53
Total United States	1602	30	254	864	132	25	3	2,910	45	2,955	3,033	2,264	+ 30.5	10,143,471	4,650	4,901	4,390

[1] Dist. 2 included with Dist. 4. [2] Dist. 5 included with Dist. 6. [3] Dist. 7-B included with Dist. 9. [4] Dist. 7-C included with Dist. 8.

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Exploration

Unusually High for January

EXPLORATORY well completions during January were unusually numerous to give a good start to the new year's exploration program that promises to be very active. Unlike past years that usually saw an easing in drilling during the first part of the year, 1948 started with more than 500 exploratory completions in its initial month. This was a slight increase over December's and considerably higher than the monthly average of last year when exploration hit an all-time record. These wells numbered over 25 percent more than those of the same period a year before and were at a level that was not reached until July, which seems to indicate that the current year will have little difficulty in becoming No. 1 in exploratory drilling.

January's completions amounted to 509, which were only slightly over December's 504, but which were 25.4 percent more than completed in January of last year. Of these tests, 97 of January's were rated as successful for a score of 19.1 percent of the total, while only 17.5 percent of those of last year's first month were producers. Included in the latest month's successful tests, and making up the largest part, were 66 new crude finds, 42 new fields and 24 new pay horizons in existing producing areas. The remaining 31 were new gas and distillate pools and extensions to fields of all types.

Of this year's 509 exploratory completions, 456 wells or 90 percent were strict wildcats with 50 wells or 11 percent successful in finding new fields. A year ago, although the totals were smaller, the wildcatting percentages were the same.

Summary of Results of Exploratory Drilling

ITEM	Jan., 1948	Dec., 1947	Jan., 1947	% Diff. Jan., '47-'48
Oil Discoveries	66	65	52	+ 26.9
New Fields	42	40	31	+ 35.5
New Pays	24	25	21	+ 14.3
Distillate Discoveries	10	5	8	+ 25.0
New Fields	3	1	4	— 25.0
New Pays	7	4	4	+ 75.0
Gas Discoveries	9	10	6	+ 50.0
New Fields	5	7	6	— 16.7
New Pays	4	3	....	.....
Total Discoveries	85	80	66	+ 28.8
Extensions to Fields	12	19	5	+140.0
Oil Fields	10	14	4	+150.0
Distillate Fields	1	2	1	.....
Gas Fields	1	3	....	.....
Total Productive Tests	97	99	71	+ 36.6
Dry Holes	412	405	335	+ 23.0
Wildcats	406	400	323	+ 25.7
New Pays	1	1	6	— 83.3
Outposts	5	4	6	— 16.7
Total Exploratory Tests	509	504	406	+ 25.4
Percent Productive	19.1	19.6	17.5	.....
Percent Dry	80.9	80.4	82.5	.....

Results of Exploratory Drilling in January, 1948, by States

STATE OR DISTRICT	JANUARY, 1948-1947																		
	PRODUCTIVE TESTS											UNPRODUCTIVE TESTS					Total Exploratory Tests	
	New Fields			New Pays			Extensions			Total Productive					Total Dry			
	Oil	Dist.	Gas	Oil	Dist.	Gas	Oil	Dist.	Gas	Jan., 1948	Jan., 1947	Wildcats	New Pays	Outposts	Jan., 1948	Jan., 1947	Jan., 1948	Jan., 1947
Alabama	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1	..	1	..
Arkansas	1	..	..	..	..	..	..	..	..	1	..	9	..	..	9	3	10	3
California	1	..	..	1	..	..	..	..	..	2	1	23	..	..	23	18	25	19
Colorado	..	..	..	..	..	..	..	..	..	..	..	7	..	..	7	..	7	..
Florida	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1	3	1	3
Illinois	1	..	..	3	..	..	2	..	..	6	11	30	..	..	30	33	36	44
Indiana	1	..	1	1	..	..	..	..	..	3	..	9	..	..	9	6	12	6
Kansas	6	..	..	..	..	..	..	..	..	6	3	36	..	..	36	30	42	33
Kentucky	..	..	1	..	..	..	1	..	..	2	..	3	..	..	3	6	5	6
Louisiana	..	..	..	5	3	..	..	..	..	8	12	13	..	..	13	22	21	34
North Louisiana	..	..	..	..	..	..	..	..	..	..	2	5	..	..	5	13	5	15
South Louisiana	..	..	..	5	3	..	..	..	..	8	10	8	..	..	8	9	16	19
Maryland	..	..	..	..	..	..	..	..	..	..	..	1	..	..	1	..	1	..
Michigan	1	..	1	..	..	..	..	..	..	2	..	19	..	..	19	22	21	22
Mississippi	..	..	..	..	..	..	..	..	..	..	2	9	..	..	9	8	9	10
Missouri	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5	..	5
Montana	1	..	..	..	..	..	..	..	..	1	..	6	..	..	6	3	7	3
New Mexico	2	..	..	2	..	..	..	..	..	4	..	7	..	..	7	7	11	7
Ohio	1	..	..	..	..	..	..	..	1	2	..	5	..	..	5	5	7	5
Oklahoma	2	2	1	1	..	..	1	..	..	7	18	49	..	..	49	48	56	66
Tennessee	..	..	..	..	..	..	..	..	..	..	..	2	..	..	2	..	2	..
Texas	24	1	1	10	4	4	6	1	..	51	23	172	1	5	178	111	229	134
Dist. 1: South Central	..	..	..	..	..	..	..	..	..	..	1	11	..	..	11	10	11	11
Dist. 2: Middle Gulf	3	..	..	1	2	1	..	1	..	8	2	20	1	2	23	9	31	11
Dist. 3: Upper Gulf	..	..	..	4	..	2	2	..	..	8	6	21	..	1	22	13	30	19
Dist. 4: L. Gulf-S.W.	2	1	1	1	2	1	..	..	..	8	5	26	..	1	27	20	35	25
Dist. 5: East Central	..	..	..	2	..	..	..	..	..	2	..	11	..	..	11	7	13	7
Dist. 6: Northeast	..	..	..	..	..	..	..	..	..	..	..	10	..	..	10	3	10	3
Dist. 7-B: N. Central	7	..	..	..	..	..	..	..	..	7	3	29	..	..	29	27	36	30
Dist. 7-C: W. Central	3	..	..	..	..	..	..	..	..	3	..	6	..	..	6	1	9	1
Dist. 8: West	3	..	..	1	..	..	3	..	..	7	3	11	..	1	12	13	19	16
Dist. 9: North	6	..	..	1	..	..	1	..	..	8	3	27	..	..	27	8	35	11
Dist. 10: Panhandle	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Utah	..	..	..	..	..	..	..	..	..	..	..	2	..	..	2	..	2	..
Wyoming	1	..	..	1	..	..	..	..	..	2	1	2	..	..	2	5	4	6
Total United States	42	3	5	24	7	4	10	1	1	97	71	406	1	5	412	335	509	406

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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in January, 1948
Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		ARKANSAS—New Oil Field						
Calhoun		Houston Oil Co's Helen B. Gaughan 1, c sw sw ne 34-13s-16w, 3 mi w Locust Bayou.	1-19-48	2048	1990- 2003	Meakin sd; U Cre	P 25	15.8
		CALIFORNIA—New Oil Field						
San Luis Obispo		Norris Oil Co's Cuyama 2, 25-11n-28w, Cuyama area	1- 2-48	1990	1880-	Vaqueros sd; Mio	F 300; 11/32"	
		CALIFORNIA—New Oil Pay						
Kings	Kettleman Hills Middle Dome	Standard Oil Co's Fee 73-30V (OWWO), 30-23s-19e	1- 9-48	12280	12072-12280	Sand; Eocene	F 600; 5 mln; 3/8"	
		ILLINOIS—New Oil Field						
Effingham	Evers	Central Pipe Line Co's J. Mette 1, se se sw 33-8n-7e, 5 mi n of prod	1-13-48	2808	2659- 2668	McClosky li; Miss	P 57; 63 wtr	
		ILLINOIS—New Oil Pays						
Edwards	Bone Gap, S.	Phillips Pet Co's Bone 1, ne ne nw 19-1s-14w	1- 6-48	3165	3058- 3060	L O'Hara li; Miss	P 45; 33 wtr	
Franklin	Whittington, W.	B. D. Jones' J. T. Johnson 1, sw sw se 14-5s-2e	1- 6-48	2804	2800- 2804	L O'Hara li; Miss	P 157	
Jefferson	Woodlawn	Magnolia Pet Co's Eubank 2 (OWWO) sw se se 35-2s-1e	1- 6-48	2200	2197- 2200	McClosky li; Miss	P 18	
		ILLINOIS—Oil Field Extensions						
Wayne	Johnsonville, W.	Robinson & Puckett's J. Smith 1, se ne sw 36-1n-5e, 1½ mi s extension	1-13-48	3114	3105- 3114	McClosky li; Miss	P 25; 60 wtr	
Wayne	Mill Shoals	Phillips Pet Co's Book 1, nw se sw 31-2s-8e, 1½ mi n extension	1- 6-48	3389	3375- 3386	McClosky li; Miss	P 189; 72 wtr	
		INDIANA—New Oil Field						
Gibson		C. M. Amsler's Mary Witherspoon 2, sw sw nw 26-2s-10w, 1 mi sw Francis W. pool.	1-30-48	2034	1927- 1935	O'Hara li; Miss	P 20	
		INDIANA—New Oil Pay						
Vanderburgh	Belknap	Geo. S. Engle-Ind Farm Bureau's John Jourdan, Jr. Comm 1, nw se se 18-6s-11w.	1-23-48	1870	1596- 1613	Biehl sd; Penn	P 150	
		INDIANA—New Gas Field						
Martin		A. B. Barrow's Webb Crane 1, sw sw sw 4-3n-4w, Perry Twp, 3 mi ne Loogootee pl.	1-30-48	1690	1497- 1520	Devonian	0.2 mln	
		KANSAS—New Oil Fields						
Barton		R. L. Williams' Soeken 1, se se sw 30-20s-11w, ½ mi n & ½ mi w Kowalsky pl.	1-18-48	3394	3381- 3394	Arbuckle li; Ord	P 312	47
Barton	Laudick	Derby Drlg Co's Laudick 1, se sw nw 28-16s-12w, 1½ mi s Beaver pl, 1¼ mi w Beaver, S. pl.	1-20-48	3432	3382- 3392	Arbuckle li; Ord	P 195	39
Butler		E. H. Adair's Corbett 1, nw ne nw 26-29s-5e, 1 mi w Box-Bush pl	1-20-48	2836	2813- 2826	Bartlesville sd; Penn	P 12	
McPherson		Westgate-Greenland et al's Burk 1, nw ne se 7-18s-1w, 1 mi s Hoffsommer pl.	1-27-48	2784	2736-	Mississippi chat; Miss	P 169	
Rice		C. E. Ash's Wendel "A" 1, sw sw nw 16-19s-10w, 1 mi nw Bowman pl	1-20-48	3357	3325-	Arbuckle li; Ord	P 30	43
Russell	Dilliner, NW.	C. G. Kessinger's Billings "C" 1, ne ne ne 27-13s-15w, 1 mi w & 1 mi n Dilliner pl.	1-27-48	3341	3328- 3341	Arbuckle li; Ord	P 39	
		KENTUCKY—Oil Field Extension						
McLean	Island	R. Hal Compton-T. M. Galey et al's Susie Kirtley 1, 19-L-28, 1½ mi nw extension.	1-23-48	1794	1778- 1793	Benoist sd; Miss	P 70; 45 wtr	
		KENTUCKY—New Gas Field						
Hopkins		Rex Alworth-Ashland's Leni Loving 1, 1-K-25, 6 mi ne Madisonville	1-30-48	2911	2220- 2236	Tar Springs sd; U Miss	5 mln	
		SOUTH LOUISIANA—New Oil Pays						
Acadia	Egan	Sun & Sohio's Kollitz Unit 1, 2341 s 692 e of nwc 7-10s-1w, s flank of fld	1-15-48	10962	10931-10934	L Miocene	F 65; 1.2 mln; 1/4"	36.8
Calcasieu	Edgerly	Sun Oil Co's Hunter Co. 6, 931 n, 922 w of sec 21-9s-11w	1-23-48	4226	4104- 4135		F 81; 5/64"	25
Jefferson	Bay De Chene	Texas Co's Lafourche Basin Levee Dist 1-C, n 17 deg 14 min w 4354 fr State-Bay De Chene well 1, 20-19s-24e.	1- 1-48	11940	10768-10796		F 146; 3/32"	35.9
LaFourche	Leeville	Texas Co's City of New Orleans 5, Sect 26-21s-22e	1-13-48	13468	12980-12985	Miocene	F 146; 1/4"	47.9
St. Martin	St. Martinville	Continental Oil Co's Fee 7-A, Sect 57-11s-6e	1-10-48	5649	4000- 4012	Miocene	F 95; 1/8"	25.7
		SOUTH LOUISIANA—New Distillate Pays						
Calcasieu	Moss Lake	Sun Oil Co's La. Farm & Livestock Co 2, 2889 s, 2035 w, of nec 7-11s-9w, 955 w disc well.	1-21-48	9350	8614- 8622		F 39; 2.3 mln; 7/16"	55.1
LaFourche	Raceland	Kenneth A. Meredith's South Coast Corp 2, Sect 34-15s-19e	1-14-48	10200	10085-10091		F 150; 1/8"	50
Calcasieu	Holmwood	Schio Pet Co's Farmers Ld & Canal Co-Mallett Unit 1, Sect 35-10s-7w, 1500 s No. 2 disc well.	12- 1-47	12001	10820-10840		F 30; 3 mln; 3/4"	52.5
		MICHIGAN—New Oil Fields						
Arenac	Sterling	Don Rayburn's G. Goodroe 1, se ne se 18-19n-4e, 1½ mi sw Deep River fld.	1-30-48	2898	2872- 2898	Dundee li; Devo	P 40	
		MICHIGAN—New Gas Field						
Washtenaw		Homer L. Heath's Ely 1, se nw ne 2-1s-7e, Salem Twp	1- 2-48	823	781- 818	Dundee li; Devo	0.3 mln	
		MONTANA—New Oil Field						
Musselshell		Texas Co's W. H. Manion 1, 340 fr sl 1525 fr el 5-11n-30e, Ragged Pt. Dome	1- 9-48	6312	4400- 4450	Kibbey sd; U Miss	F 228	34
		NEW MEXICO—New Oil Fields						
Lea		Delfern Oil Co's Lea-State 1, 1980 fr n&wl 8-17s-34e, 3 mi nw Vacuum pl.	1-12-48	4723	4673- 4723	San Andres li; Perm	F 333; 1"	37
San Juan		Petroleum Products Refg & Prod Co's Santa Fe 1, 2310 fr n&wl 21-31n-8w, 9 mi ne Blanco fld.	1-10-48	4707	3531- 3600	Mancos sh; U Cre	P 10	
		NEW MEXICO—New Oil Pays						
Lea	Monument	Amerada Pet. Corp's J. R. Phillips et al 5, 660 fr n&el 1-20s-36e	1-14-48	9953	5180- 5200	Glorietta sd; Perm	F 840; 1/2"	40.3
Lea	Watkins	Peckham & Clark's Hightower 1 (OWDD), 660 fr sl 1980 fr wl 31-18s-32e. 9 mi sw Vacuum pl.	1- 9-48	4252	4217- 4252	Grayburg sd; Perm	P 49	27
		OHIO—New Oil Field						
Morgan		Fred Beasley et al's Luther Tippie 1, Sect 3, Malta Twp. 12 mi s Brush Creek fld.	1- 5-48	4659	4654- 4659	Medina sd; Sil	P 25	
		OHIO—Gas Field Extension						
Lorain	Ashland	Ohio Fuel Gas Co's H. F. Gustafson 1, Lot 25, Sect 1, Penfield Twp	1-16-48	2468	2459- 2465	Clinton sd; Sil	1.3 mln	
		OKLAHOMA—New Oil Fields						
McClain	Newcastle, SE	Mid-Continent Pet Corp's Berry Est. 1, nw sw nw, 32-9n-3w, 5 mi n of Norman.	1-15-48	9850	8784- 8830	Hunton li; Devo	F 422; 3/32"	43
Pottawatomie		E. C. Clay & Son Inc's School Land 1, se se nw 36-6n-2e	1-15-48	4886	4566- 4574	Viola li; Ord	P 20; 30 wtr	38
		OKLAHOMA—New Oil Pay						
Seminole		Keener O & G Co's Jackson "A" 3, se ne ne 29-7n-7e	1- 8-48	1788	1778- 1788	Calvin sd; Penn	P 75; 100 wtr	33
		OKLAHOMA—Oil Field Extension						
Stephens	Sholem Alechem	Carl B. Anderson's R. L. Calmes 1, nw sw se 35-1n-4w, n extension	1-15-48	5188	5152- 5188	Springer sn sd; Penn	P 201	29
		OKLAHOMA—New Distillate Fields						
Beckham	Elk City	Shell Oil Co's Walters 1, c ne sw 14-10n-21w	1-22-48	13133	9260- 9360	Granite Wash; Penn	F 469; 5.7 mln; 1/2"	65.4
Payne	Sporn, NE	B. C. Deardorf's Anderson 1, sw sw ne 15-17n-3e	1- 8-48	4614	3945- 3980	Red Fork sd; Penn	F 5; 10 mln	dist.
		OKLAHOMA—New Gas Field						
Pontotoc	Steedman, SW	Foran, Nowels & Foran's Gipson Johnson 1, sw ne se 30-4n-8e	1-15-48	842	491- 510	Sand	0.1 mln	
		TEXAS—District 2 (MIDDLE GULF COAST)—New Oil Fields						
Calhoun	Long Mott	Fullerton Oil Co & Ryan Consolidated Oil Co's Margaret F. Roemer 1, 3300 fr nel, 393½ fr sel of 285-ac lse, Mathew Dockery Sur 2, 4 mi e-se of Long Mott.	1- 8-48	7800	7674- 7688	Marginulina sd; Olig	F 75; 11/64"	44
Goliad	Charco	W. C. McBride Inc et al's W. A. Stockton 1-B, 467 fr n&wl of 85-ac "B" lse, Victor Blanco Gr, 3 mi n-ne Hord's Creek fld.	1- 1-48	8511	4590- 4595	Yegua sd; Eoc	F 33; 1/2"	48.6
Wilson	Reklaw	W. C. McBride Inc's C. E. Hart 1-A, 950 fr nwl 920 fr swl of 145.8-ac lse, Simon & Juan de Arocha Sur, 1½ mi ne Floresville fld.	1-27-48	592	587- 588	Reklaw sd; Eoc	P 19; 16 wtr	16.8
		TEXAS—District 2 (MIDDLE GULF COAST)—New Oil Pay						
Goliad	Hord's Creek	Brown & Wheeler's J. R. Kauffman 1-A, (OWDD), 330 fr swl 1750 fr se'ly sel of 175.63-ac "A" lse, P. Trevino Gr.	1- 2-48	5148	5062- 5072		F 133; 1/8"	48
		TEXAS—District 2 (MIDDLE GULF COAST)—New Distillate Pays						
Live Oak	Harris	Continental Oil Co's Frank C. Goodwin 1-A, 500 fr nwl 660 fr nel of Juan Gimines Sur, 1½ mi n-ne Geo West Twst.	1-26-48	8750	8588- 8610	Wilcox sd; Eoc	F 28; 2.9 mln; 1/4"	46.2
Refugio	La Rosa, N.	Phillips Pet Co's J. G. Toland 2, (OWWO), 467 fr nl 1980 fr el Sect 39, Johnson & Pugh Subd of Bonnie View Ranch, Guadalupe C. Cobian Gr.	1- 8-48	6280	5616- 5624		F 29; 1 mln; 1/8"	dist.
		TEXAS—District 2 (MIDDLE GULF COAST)—Distillate Fld. Ext.						
Live Oak	Kittie West	Continental Oil Co's Kittie West Schreiner 2-A, 2200 e th 200 s fr intersection of wl & swl of D. R. Fant Sur 6, 1½ mi sw extension.	1-26-48	7503	6740- 6748	Slick sd; Eoc	F 22; 1 mln; 1/2"	45.3

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New Oil, Distillate and Gas Fields and New Pay Horizons Discovered in the United States in January, 1948 (Cont'd)

Also Important Extensions to Established Fields

COUNTY	FIELD	COMPANY, WELL AND LOCATION	Date Completed	Total Depth (Feet)	Completion Horizon (Feet)	[1]Name, Character and Age of Producing Formation	[2]Initial Production Method and Choke	Gravity of Oil
		TEXAS—Distrcit 2 (MIDDLE GULF COAST)—New Gas Pay						
Refugio	Fagan	C. L. Norsworthy Jr. et al's C. T. Holeman 1-B, 1713 fr sl 251 fr e&wl of 200-ac Tr out of Holeman Land in Michael Reily Sur, 3300 se of Fagan fld.	12-22-47	6035	2354- 2363		14.5 mln; open	
		TEXAS—District 3 (UPPER GULF COAST)—New Oil Pays						
Chambers	Jergins	Texas Co's Annie Schilling et al 1, Christian Smith Sur, 330 fr sl 4065 fr el of lse, 882.68 sw No. 2 well.	1- 2-48	7012	6440- 6444	Frio sd; Olig	F 234; 1/8"	39.6
Chambers	Jergins	Texas Co's Annie Schilling 2, Christian Smith Sur, 330 fr sl 3132 fr el 1000-ac lse.	1-18-48	6550	6395- 6399	Marginulina sd; Olig	F 183; 3/64"	36.1
Harris	Pierce Jctn, S.	McCarthy O&G Corp & Gulf Oil Corp's Vivian Smith 1, Jas. Hamilton Sur, Sect 53, 650 fr nl of lse & Sur 775 e'ly at ra fr I&GNRR ROW.	1-27-48	7630	7360- 7367		F 227; 3/64"	32.3
Newton	Gist	Standard Oil of Texas' J. S. Peters et al 1, 467 fr w&nl of J. D. Bland Sur.	1- 1-48	7255	7196- 7197	Hackberry sd; Olig	F 156; 3/64"	38.8
		TEXAS—District 3 (UPPER GULF COAST)—Oil Field Extensions						
Hardin	Village Mills	Houston Oil Co & American Rep Corp's Rice Institute 2, Chas. Stewart Sur, 1960 fr sl 750 fr el of Tr & Sur, 1½ mi sw extension.	1-13-48	10636	9025- 9037	Wilcox sd; Eoc	F 84; 3/32"	35.4
Waller	Katy	Houston Oil Co's John M. Harris et al 1, J. M. Bennett (H&TC) Sur, 2227 fr el 1980 fr sl of 320-ac lse & Sect 86, ½ mi nw extension.	1- 5-48	7398	6871- 6873		F 47; 3/64"	41
		TEXAS—District 3 (UPPER GULF COAST)—New Gas Pays						
Wharton	Twin Basin	Floyd L. Karsten's W. T. Ellis 1, 80-ac lse, w½ ETRR Sur, Sect 23.	1-17-48	7154	6586- 6597		no gge	
Wharton	Hutchins, S.	Adams & Haggarty's Kenneth A Meek et ux 1, I&GN Sur, Sect 16 & 17, 330 fr ne&sel of 75.71-ac lse.	1- 8-48	5924	3205- 3211		1.7 mln; ¼"	
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Oil Fields						
Jim Wells	Bandera, N.	La Gloria Corp's Adolph Moos 1, 467 fr sl 4650 fr el 924-ac lse in Las Anacuas Gr to Vicente Ynojosa, 2 mi ne Bandera fld.	1-10-48	6520	6234- 6246	Jackson sd; Eoc	F 2	
Nueces	West Corpus	Tide Water Assoc Oil Co's Guaranty Title & Trust Co 1, 660 fr n&wl of 5, J. C. Russell farm lots in Enrique Villareal Gr on 1716.5-ac lse, ¾ mi se Saxet-Deep fld.	1-16-48	11490	11115-11170	Basal Frio sd; Olig	F 198; 3/32"	46.2
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Oil Pay						
Duval	Squire	Santa Clara Oil Co & John F. Camp & Sons' Jas. F. Welder Hrs 8-C, 2100 fr swl 600 fr sel of M. G. Nunez Sur. 4.	1-28-48	3890	3757- 3760	Pettus sd; Eoc	F 93; 3/16"	35
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Dist. Fld.						
Duval	Longhorn, S.	Hiawatha O&G Co's Leroy Denman 1-A, 3850 fr sl 7020 fr el of 4246.6-ac lse, Santos Garcia Gr, 1 mi sw Longhorn fld.	1- 8-48	5757	4844- 4852		F 185; 10 mln; open	
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Dist. Pays						
Aransas	Fulton Beach	Wm. H. Hunt Trust Est's Spencer-Kent-Crane 4, 5230 fr sl (parallel with el) 467 fr nel (at ra) of 720-ac lse in C.O.D. Gilliland Sur	1-10-48	7471	6947- 6954		F 1; 0.02 mln; open	56.8
Brooks	Cage Ranch	Shell Oil Co's Jimmie Lenora Cage 2-C, 6195 fr el 12,350 fr sl Leonardo Vargas Gr.	1-16-48	8348	7800- 7820		F 138; 3.6 mln; ¼"	59.2
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Gas Field						
San Patricio	N. Mathis	Fred M. Manning's Ross-Singleton 1, 1500 fr nel 2850 fr nwl of I&GN Sur, Blk 3, 575.86-ac lse, 3 mi n Mathis.	1-26-48	5010	3490- 3495		7 mln; open	
		TEXAS—District 4 (LOWER GULF-SOUTHWEST)—New Gas Pay						
Starr	Sun, N	Sun Oil Co's Ramon Olivares et al 1, 2150 fr wl 21,000 fr sl Santa Teresa Gr, ½ mi ne prod.	1- 6-48	6835	4500- 4507		10.5 mln; open	
		TEXAS—District 5 (EAST CENTRAL)—New Oil Pays						
Grayson	Sherman	Standard Oil of Texas' J. M. Head Estate 1, 660 fr el 430 fr sl of 197-ac Tr in J. Jennings Sur, 2 mi nw Sherman.	1- 1-48	3306	3296- 3306	Strawn series; Penn	F 256; ¼"	35
Grayson	Sherman	Standard Oil of Texas' Mary H. Rifenburg 1, 1125 fr el 467 fr sel of John Jennings Sur, 330 fr swl of lse, 1 mi ne Sherman.	1- 5-48	4857	4340- 4355	Strawn series; Penn	F 109; ¼"	36
		TEXAS—District 7-B (NORTH CENTRAL)—New Oil Fields						
Brown		G. C. English's F. H. Madison "A" 2, 330 fr n&wl of Blk 10, Juan Delgado Sur 789, 10 mi e Cross Cut.	1- 7-48	2205	2078- 2102	Caddo li; Penn	F 104; ¾"	41
Commanche		T. A. Kirk et al's S. D. Mears 1, 4600 fr sl 3900 fr wl Wm DeMoss Sur, 2 mi e Gorman.	1-21-48	2811	2790- 2811	Marble Falls li; Penn	F 308; ¼"	40
Jones		E. H. R. Sabens et al's B. J. Rutledge 1, 330 fr nl 2090 fr wl F. Sieberman Sur. 13, 10 mi ne Abilene.	1- 9-48	1896	1717- 1726	Lime	P 22	38
Shackelford		Humble O&R Co's P. W. Pitzer 1, 660 fr nw&swl of Sect 507 TE&L Co Sur, 8½ mi ne Albany.	1- 1-48	4566	4510- 4595	L. Mississippian li;	P 63; 14 wtr	41.5
Throck-morton		J. H. Snowden's Mrs. F. Marrs 1, 1500 fr el 950 fr sl Sect 289 BBB&C Sur, 1½ mi se Throckmorton.	1- 8-48	4901	4734- 4740	Marble Falls cgl; Penn	P 66; 34 wtr	37.9
Throck-morton		J. H. Snowden et al's T. J. Wright 1, 2500 fr nl 1450 fr wl Sect 294 BBB&C Sur, 2½ mi se Throckmorton.	1- 8-48	4784	4744- 4764	Mississippi li; Miss	F 192; ¼"	
Throck-morton		H. C. Manning et al's Manning-Graham et al 1, 514 fr nl 1648 fr el of Sect 994 TE&L Sur, 2½ mi ne Woodson.	1- 3-48	4055	3908- 3928	Caddo li; Penn	P 51	41
		TEXAS—District 7-C (WEST CENTRAL)—New Oil Fields						
Coke		Sun Oil Co's J. B. Walker 1, 660 fr se&swl C. Brockhuysen Sur 526	1- 1-48	6260	6114- 6260	Crinoidal li; Penn	F 444; ¼"	48
Coke		Sun Oil Co's J. W. Arledge 1, 1980 fr s&wl Sect 261, Blk 1-A, H&TC Sur.	1-19-48	6820	6598- 6617	Marble Falls li; Penn	F 176; ¼"	47.8
Runnels		Pan American Prod Co's Hugh Campbell 1, 467 fr n&el J. Hays Sur, 630	1- 2-48	4589	3536- 3547	Morris sd; Penn	P 8	35.6
		TEXAS—District 8 (WEST)—New Oil Fields						
Cochran		Atlantic Ref. Co et al's F. O. Maston 1, 660 fr n&wl Lab. 15, Lge 132, Carson CSL Sur, 16 mi sw Morton.	1-21-48	5050	4950- 5050	San Andres li; Perm	P 42; 24 wtr	27
Crane	"C-Bar"	Gulf Oil Corp's Hattie Connell et al 1-S1-A, 1980 fr sl 660 fr wl Sect 26, Blk B-22, PSL Sur, 3½ mi n Sand Hills fld.	1-26-48	9915	8355- 8365	Fusselman li; Sil	F 1805; ½"	35.9
Ector		J. W. McMillen et al's J. H. Emmons 1, 660 fr n&wl Sect 8, Blk 42, T-3-S, T&P Sur, 5 mi sw Odessa.	1-18-48	4550	4465- 4489	Grayburg li; Perm	P 242	35.4
		TEXAS—District 8 (WEST)—New Oil Pay						
Gaines	Seminole	Amerada Pet Corp's T. S. Riley 9, 660 fr sl 725 fr el Sect 229, Blk G, WTRR	1- 1-48	6898	6336- 6536	San Angelo sd; Perm	F 147; 2"	27.6
		TEXAS—District 8 (WEST)—Oil Field Extensions						
Andrews	Midland Farms	Stanolind O&G Co's Midland Farms 3-Q, 660 fr s&el Sect 9, Blk 42, GM-MB&A Sur, s extension.	1- 1-48	4813	4650- 4793	Grayburg li; Perm	F 144; ¼"	32
Andrews	Bedford Devonian	Shell Oil & Texas Co's Ratliff & Bedford 6, 1980 fr nl 3300 fr el Sect 4, Blk 73, PSL Sur, w extension.	11- 1-47	11336	11215-11288	Ellenburger dolo; Ord	F 1244; ½"	45.3
Glasscock	Howard-Glasscock	R. U. Fitting Jr's W. R. Settles 1, 1650 fr s&el of Sect 158, Blk 29, W&NW Sur, ¾ mi s extension.	1- 1-48	1437	1408- 1430	Yates sd; Perm	P 27	32
		TEXAS—District 9 (NORTH)—New Oil Field						
Archer		Reno Oil Co's L. F. Wilson "Estate" 1, 150 fr nl 925 fr el, Blk 34, Geraldine Sur, 5 mi s Holliday.	1- 3-48	1582	1573- 1582	Cisco sd; Penn	P 6; 3 wtr	
Jack		Warren Oil Corp's Ida & May Moore "D" 11, 2280 fr sl 990 fr wl J. W. Williams Sur, 6 mi s Antelope.	1-20-48	4602	4565- 4578		P 34	
Montague		A. R. Dillard et al's H. G. Walker "B" 1, 467 fr nl 382 fr wl of farm in Sect 18, Limestone CSL Sur, 3 mi n Stoneburg.	1- 8-48	6470	4948- 4965	Strawn sd; Penn	F 191; ¼"	41.2
Montague		Sinclair Prairie Oil Co's Mary Gronow 1, 1400 fr nl 467 fr wl, L. F. Fisch Sur, 1 mi sw Montague.	1-19-48	6490	4079- 4089	Strawn sd; Penn	P 215; 12 wtr	41
Montague		Continental Oil Co's C. P. Miller 1, 660 fr n&wl of sw¼ of Lot 5, Sect 21, Limestone CSL Sur, 1½ mi w Stoneburg.	1-31-48	6344	6196- 6212	Bend cgl; Penn	F 684; ½"	43
Young		Star Oil Co's Melba Raley 1, 330 fr n&wl W. Hill Sur, 3 mi sw Bryson fld.	1-25-48	4774	4764- 4774	Chappell li; Miss	F 213; 1/4	41.5
		TEXAS—District 9 (NORTH)—New Oil Pay						
Young		Nu Enamel Oil Corp's R. L. Merrison 1, 1671 fr nl 705 fr el Sect 465, TE&L Sur, 6 mi nw Graham.	1-14-48	4651	4632- 4651	Mississippi li; Miss	F 129; 1/8"	43
		TEXAS—District 9 (NORTH)—Oil Field Extension						
Clay	Acme	Fain & McGaha's G. W. Scaling 1, 1650 fr nl 330 fr el Sect 1, HT&B Sur, ½ mi sw extension.	1- 2-48	4107	4075- 4107	Strawn sd; Penn	P 114; 17 wtr	41
		Wyoming—New Oil Field						
Fremont	Sage Creek, N.	Stanolind's Shoshone-Arbuckle "B" 1, 1598 fr sl 1513 fr wl Sect 4-1n-1w	12-22-47	2525	2070- 2159	Phosphoria li; Perm	P 21; 128 wtr	19
		WYOMING—New Oil Pay						
Sweetwater	Lost Soldier	Sinclair-Wyoming's Unit 77-1 (OWDD), se ne ne 10-26n-90w	1- 9-48	5039	4950- 5030	Madison li; Miss	F 1045; 2¾"	35

[1] Character of producing formations abbreviated thus: ch, chalk; dolo, dolomite; li, limestone; sd, sandstone; sh, shale; ser, serpentine; cgl, conglomerate. Ages of formations abbreviated thus: Plio, pliocene; Mio, Miocene; Olig, Oligocene; Eoc, Eocene; U. Cre, Upper Cretaceous; L. Cre, Lower Cretaceous; Jur, Jurassic; Tri, Triassic; Perm, Permian; Penn, Pennsylvanian; U. Miss, Upper Mississippian; L. Miss, Lower Mississippian; Devo, Devonian; Sil, Silurian; Ord, Ordovician; Cam, Cambrian.

[2] Barrels of oil per day (24 hr. rate), flowing (F), pumping (P), swabbing (Sw), or bailing (B); or million cubic feet of gas daily open flow capacity; size of choke given in inches.

Giant Rig for DEEPEST MARINE DRILLING

by

ELTON STERRETT Engineering Editor

DESIGNED and engineered to meet the problems of 18,000-foot drilling, Shell Oil Company, Inc.'s new barge unit, known so far only as Marine Rig. No. 7, and now operating in the Weeks Island field, Iberia Parish, Louisiana, is the largest and most powerful steam rig built to date. Towering 225 feet above the marsh on which it rests, and with a working floor area 40 feet square, the rig dwarfs the massive equipment with which it is outfitted, and its immense height and spread are apparent only when another standard derrick is nearby, or when the rotary is viewed from the gin pole runaround.

Nearly two years of design, planning and selection of component parts of the equipment preceded the first actual service test of the rig. Not only was each unit chosen for its ability to drill to or beyond the nominal depth, but each also was coordinated with others to produce a completed rig which would handle all anticipated loadings and would at the same time be capable of resisting hurricane winds of 125-mile velocity when a full complement of pipe was racked in the derrick.

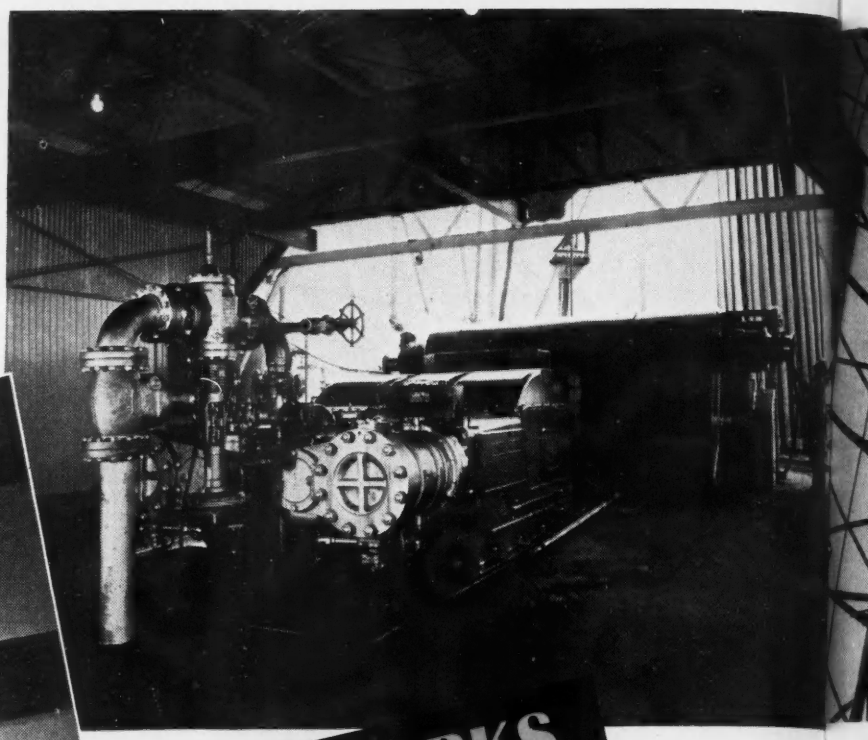
Barge Design

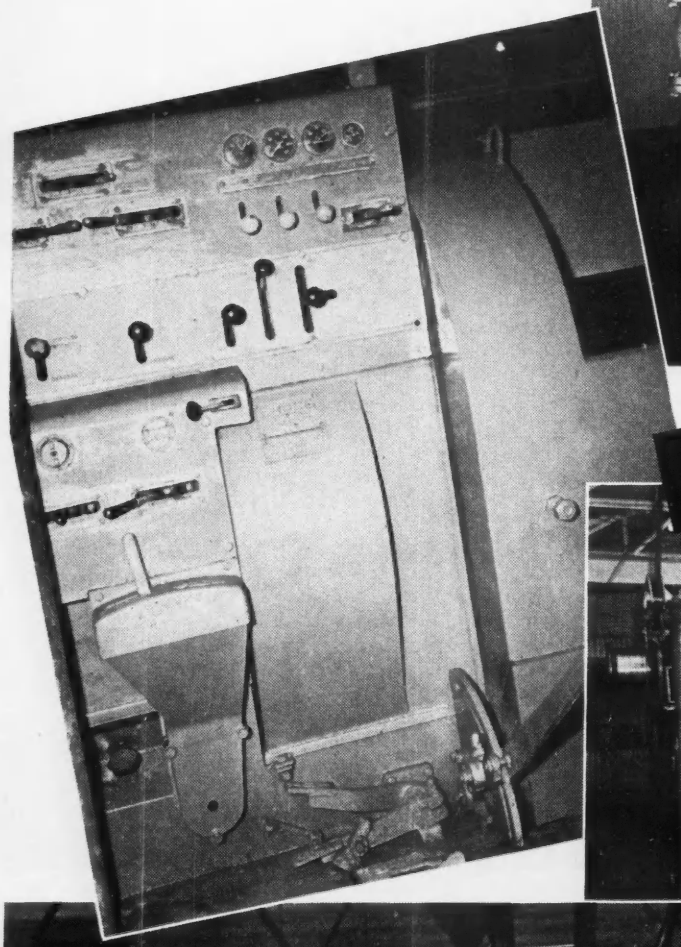
The barge which carries No. 7 is a single hull, constructed in accordance with American Bureau of Shipping standards and inspected and certified by that agency. The barge is 152 feet long and 54 feet wide. The hull is 14 feet, of which about nine feet is designed to be submerged when the barge is in place and resting on bottom. Floating draft, when readied for shifting through a canal to a new location, is approximately seven feet fully loaded. The single unit is provided with an eight-foot wide slot extending into it 84 feet from the forward or pipe-rack end of the barge. This slot extends upward to the deck and is braced and completed as an outside portion of the hull. On location, the well site is marked by

COMBINING heavier equipment with air controls which lessen the heavy work demands imposed on the crew, this new barge rig uses 135-foot stands of five-inch pipe in a 186-foot derrick with a 40-foot square working floor. The unit is designed for 18,000-foot drilling, under most severe conditions.

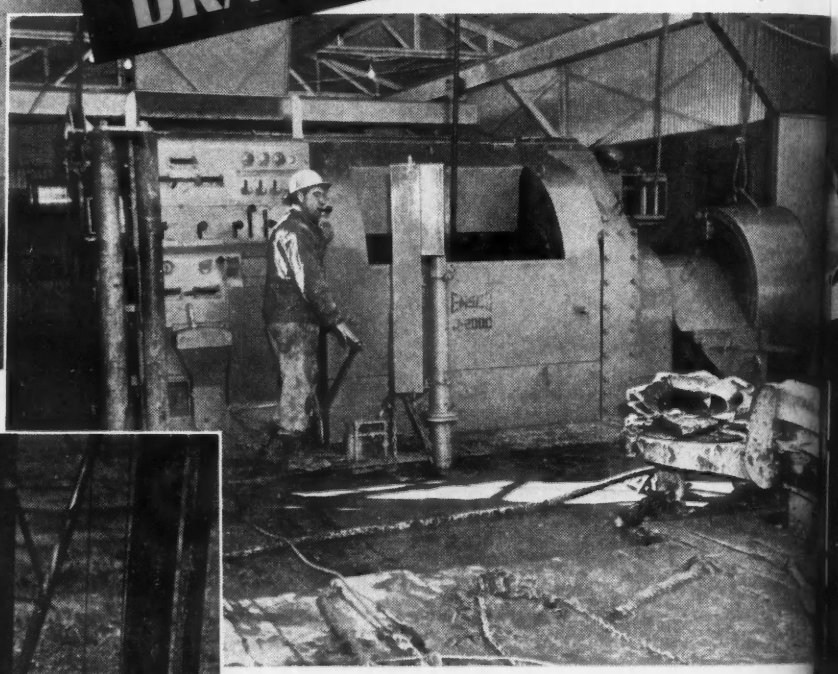
RIGHT: The 16x16 engine and drawworks which handle the heaviest loads encountered in deepest drilling with the five-inch pipe. The six-foot driller is dwarfed by the units under his control.

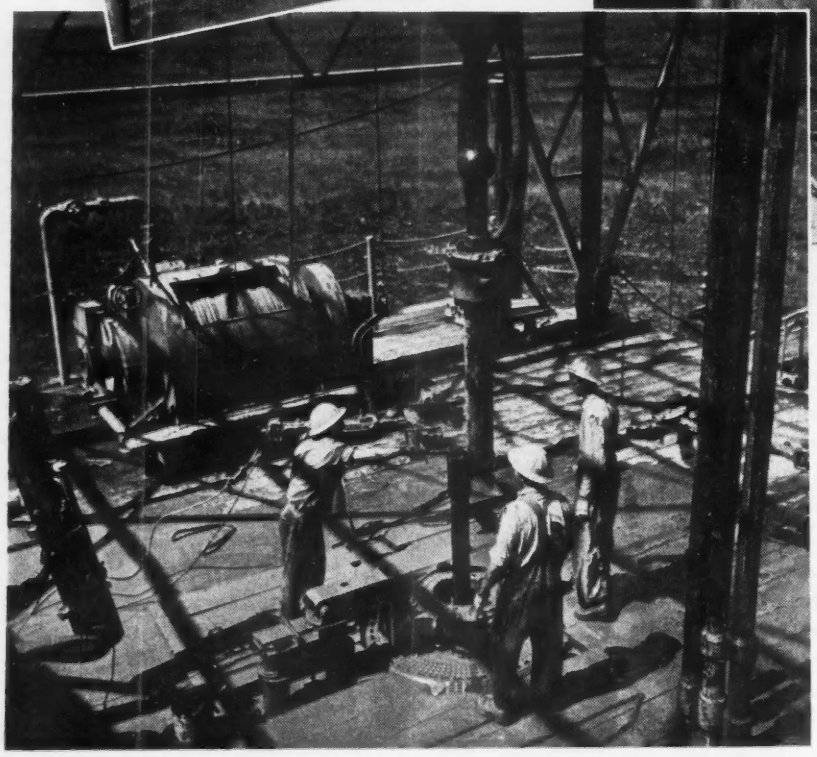
BELOW: The push-button and lever control panel which supplants all the heavy work of clutch and gear shift operations and centralizes operation under the hand and eye of the driller.





DRAWWORKS





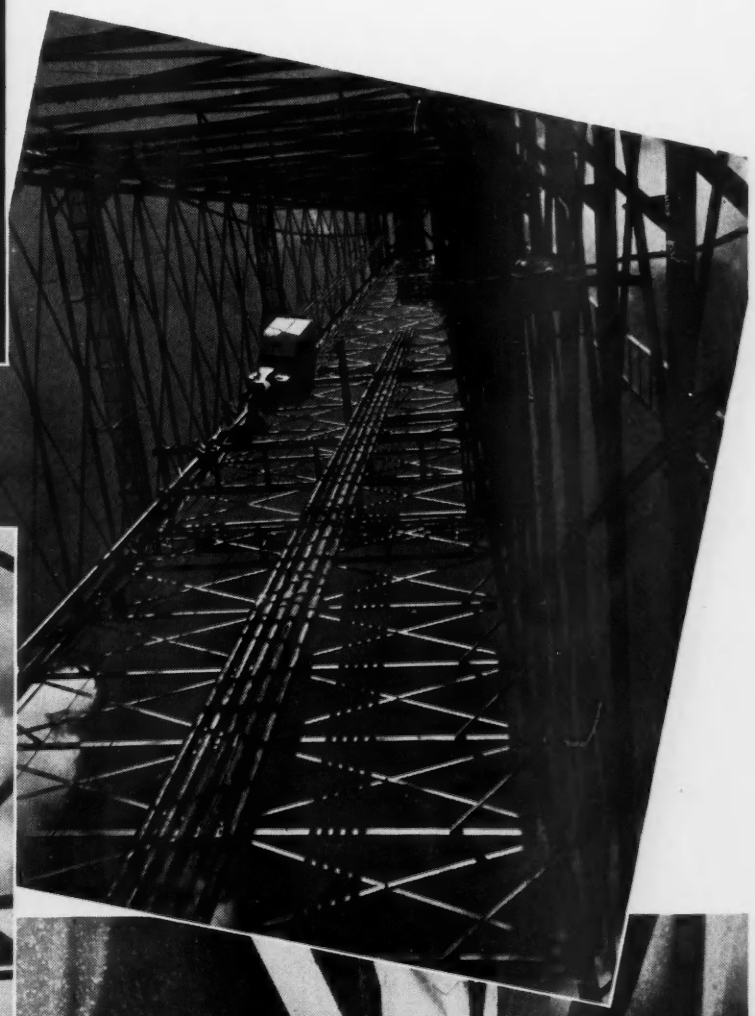
ABOVE: The drawworks carries the line on a 60-inch drum, and is driven by an engine on the main deck of the barge. The main shaft is equipped with dynamatic brake as well as usual twin friction drums.

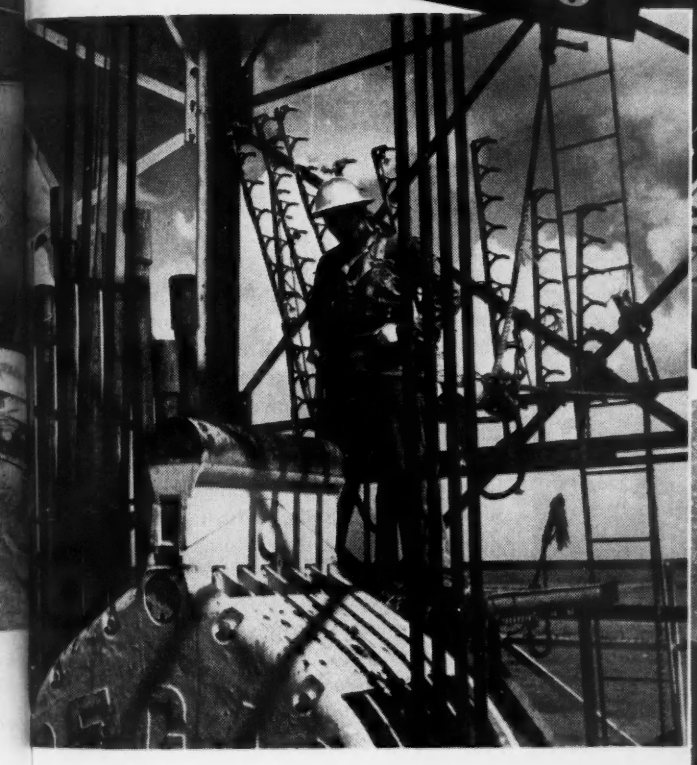
LEFT: The separately powered sand line is set across the floor from the driller, and is equipped with cathead for light lifts. Spaciousness of the 40-foot square floor is here evident in the work room available to the crew.

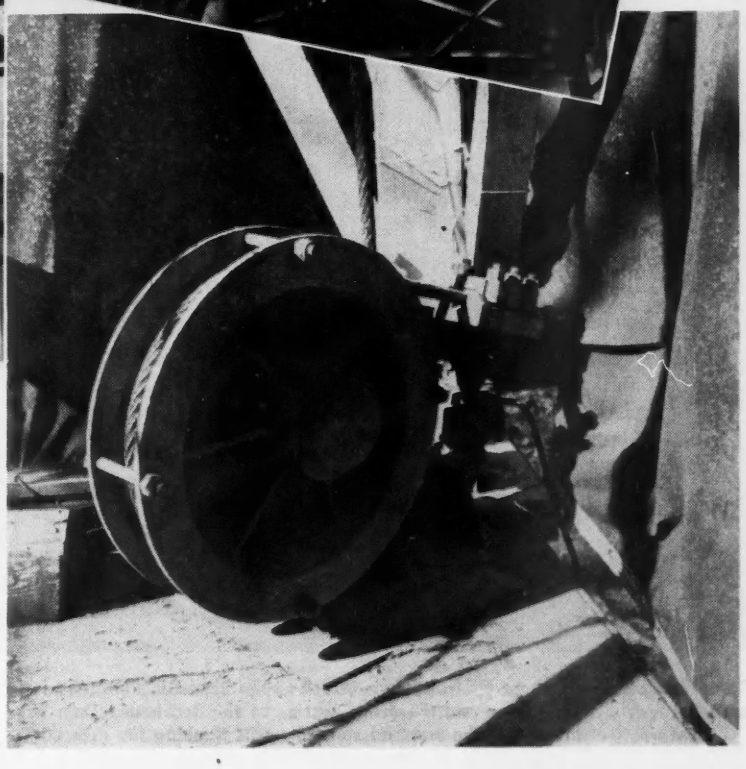
LEFT: The six-sheave traveling block is serviced from a bo's'n's chair and carries the eight- or ten-line stringup according to depth on its 60-inch sheaves.

BELOW: Looking a long way up into the 185-foot derrick. The ample freeway through the rig affords ample block clearance even when handling stands in a high wind.

LINE HANDLING







ABOVE: The rubber stop on the traveling block as it comes even with the derrickman's 135-foot high post. Racking fingers help stack the long pipe free of the line.

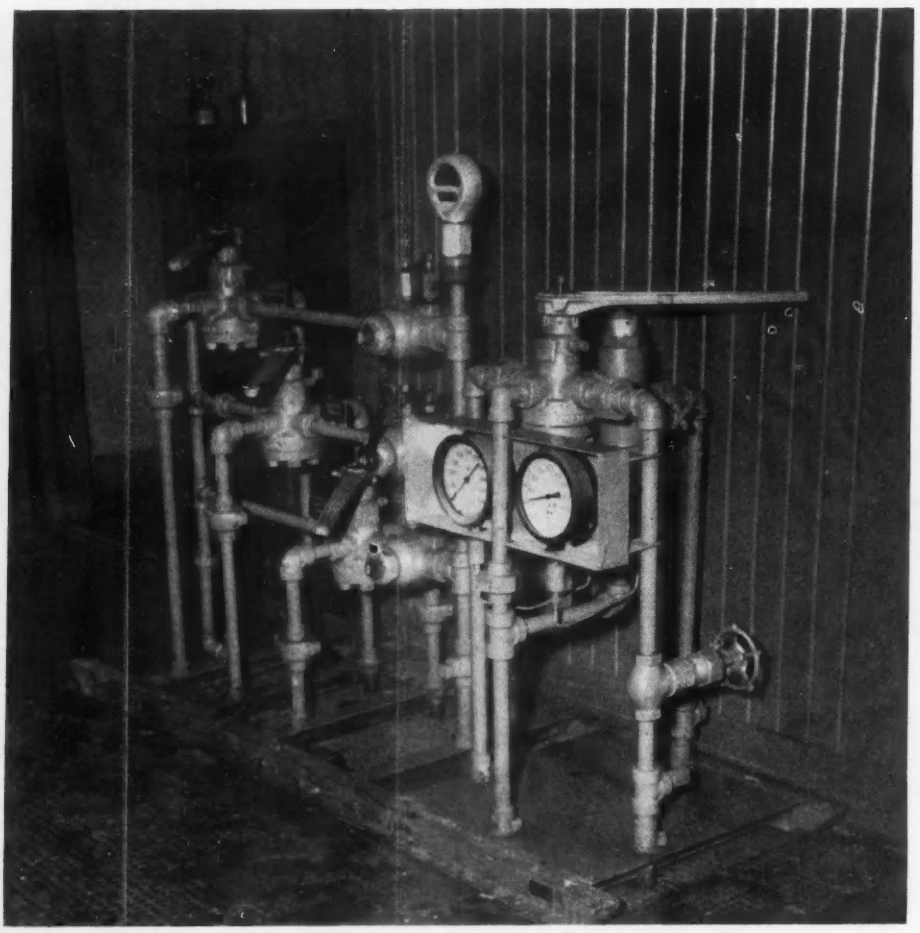
RIGHT: The dead-line anchor is also the fulcrum of the weight-indicating device. Wrapped four times around this drum and securely clamped, line may be fed through this device readily to replace drum rejects.

two parallel rows of piles, driven deep into the marsh, and spaced to fit snugly within the clearance slot. These parallel rows of piling, serving to guide and align the barge during placing operations, also act as foundation for the wellhead equipment and servicing platform on completion. The pipe-rack section of the slot is floored over with heavy plate at working level to provide a hazard-free working area.

Six main compartments are built into the hull, with collision bulkheads provided in the rake of each end. The main compartments are fitted with sea cocks and are used for submergence water. Steam ejectors in these tanks provide for dewatering for flotation. Mud pits are built into the after end, with a rectangular flow channel or mud ditch around and over them. High-pressure jets or suction brakes allow the hull to be jetted free if buoyancy is insufficient to free it from the marsh after dewatering.

Compartment bracing is designed to transfer the concentrated loading from the rotary table and from the derrick legs to the entire flat bottom of the hull, so as to equalize pressures and insure maximum foundation support. Flooding control during submergence is used to bring the hull to rest on an even keel. Two I-beam spuds may be used to anchor the unit and prevent shifting under load or tidal wash.

The 15-foot substructure is in effect a continuation of the cross-braced and reinforced hull unit, being designed to transfer loading uniformly and to afford maximum support to such units as engine, drawworks, rotary and pipe rack. All junctions are welded, so that the entire substructure functions as a structural unit. Space between barge deck and working floor is ample to accommodate all below-floor equipment, and to provide adequate and stable working space for maintenance operations. Stairways at strategic points communicate with a runaround halfway between deck and working floor, with flights on each side reaching to the main level. All walkways are provided with handrails and toeboards. The substructure legs which carry the derrick directly above them are designed for 150-ton loading each. The 36-inch, 236-pound beams which support the rotary are designed to support a dead load of 350 tons in the center. Derrick floor beams, pipe-rack beams and plate beneath the pipe rack, as well as all members of the derrick proper, are galvanized to afford maximum protection against corrosive action of salt water of the bayous.



The skid-mounted blow-out control unit is bolted to the upper decking, and is located just off the aisle between drilling engine and the office section of the deckhouse. Door beyond the unit leads into one of the material storage rooms flanking the drawworks.

An illustration of the care devoted to details on the design of this rig is the manner in which rounds are welded over the flange edges of all I-beams and channels used in the substructure construction. These rounded surfaces protect hoses, extension light cords and personnel from injury.

The 476-ton derrick itself (API rating) is 185 feet high, and is surmounted by a 15-foot gin pole with a 15-ton capacity. The enclosed area ranges from the 40-foot square floor area to an opening six feet, 8 inches in the crown. The V has 31-foot clearance to enable 45-foot pipe joints to be handled without fouling against the derrick girt.

Pipe Handling

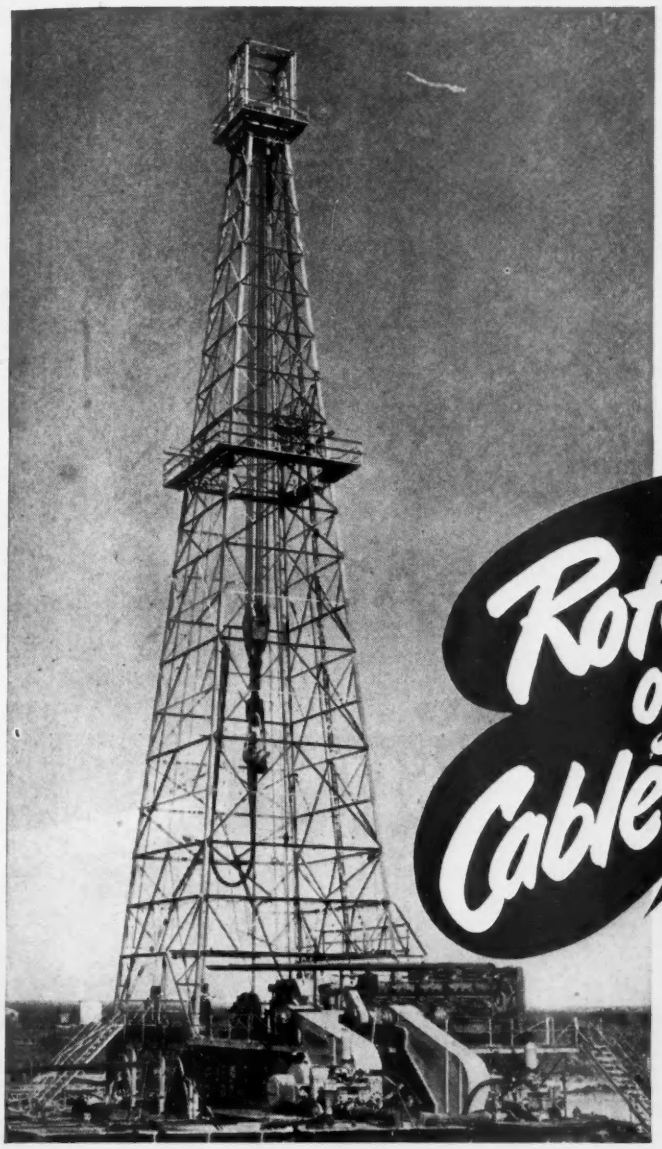
Five-inch outside diameter 19.40-pound internal upset drill pipe is used on this rig. The pipe is made up through a mousehole flanking the rotary toward the V. Pipe is racked in thribbles. Since each joint of pipe averages 42 to 45 feet in length, the thribbles run up to as high as 135 feet in over-all length. Even of five-inch pipe, considerable flexing is encountered in a stand. To support this pipe adequately in the rack, an auxiliary support is provided at approximately 80 feet above the floor. Here a heavy finger, equipped with a short spud at the end to retain the stand once it has been placed, serves to align the pipe as it is stacked, and to provide support for each stand as it is added to those already placed. A second finger, normally stored out of the way against the starboard side of the derrick, is arranged so that it may be lowered into place to furnish support for the pipe just below the first joint. This auxiliary finger is used when high winds make the handling of drill pipe difficult.

With one third fewer stands of pipe than when using 90-foot thribbles, the floor area provided for stacking the five-inch pipe requires less angularity than with shorter stands, reducing the work demanded of the derrickman in controlling and guiding the stands to their proper places in the racking fingers.

Safety platforms are installed at each racking position, and the derrickman's stand is equipped with a heater coil to lessen the rigors of the chill winds which, 135 feet above the marsh, have a clear sweep at him.

Line Handling Equipment

The drawworks is the largest constructed to date, and is the first one of its type to be put into service. The drum is ungrooved, 34 inches in diameter, with a spooling length of 60 inches. It is equipped with 60-inch brake rims. The drawworks is rated at 2000 input horsepower, and has four speeds. All clutches are pneumatic, operated from a panel at the driller's side of the unit. An inter-



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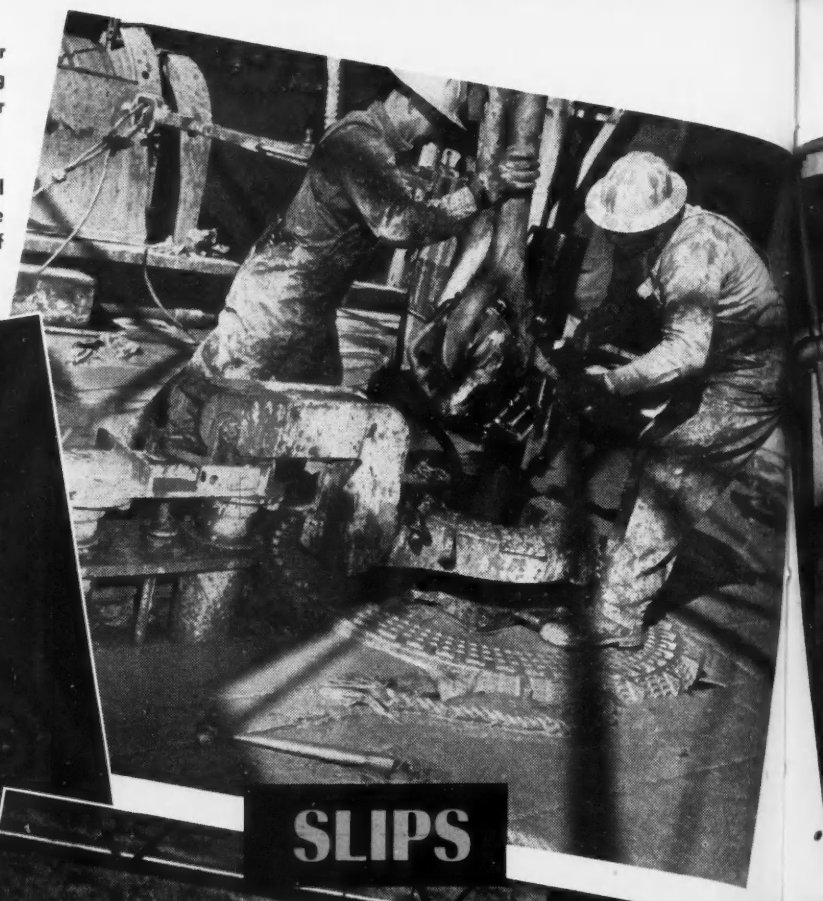
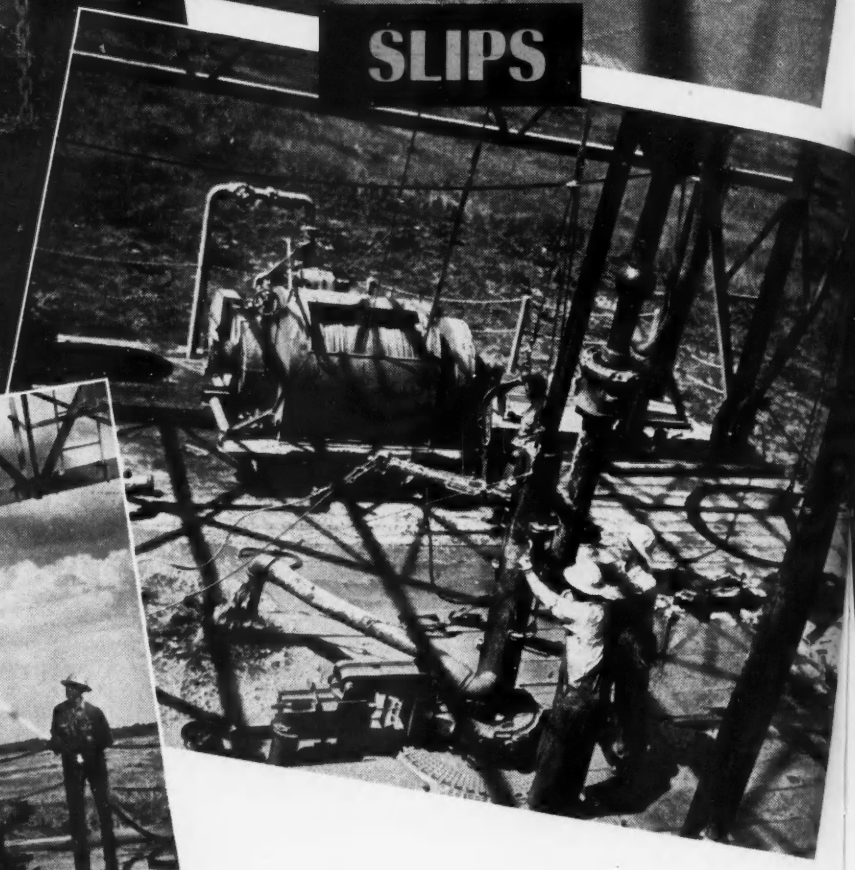
RIGHT: The air-operated slips are slung below possible elevator contact, and do not impede floor work. The supporting or lifting ring frequently affords footrest for better control of elevators or thribble.

BELOW: These two pedals, handy to the driller's right foot, do all the work of controlling the slips. The right pedal sets the slips, the other admits air to lift the unit as the rising pipe frees the slips of their friction load.



SLIPS



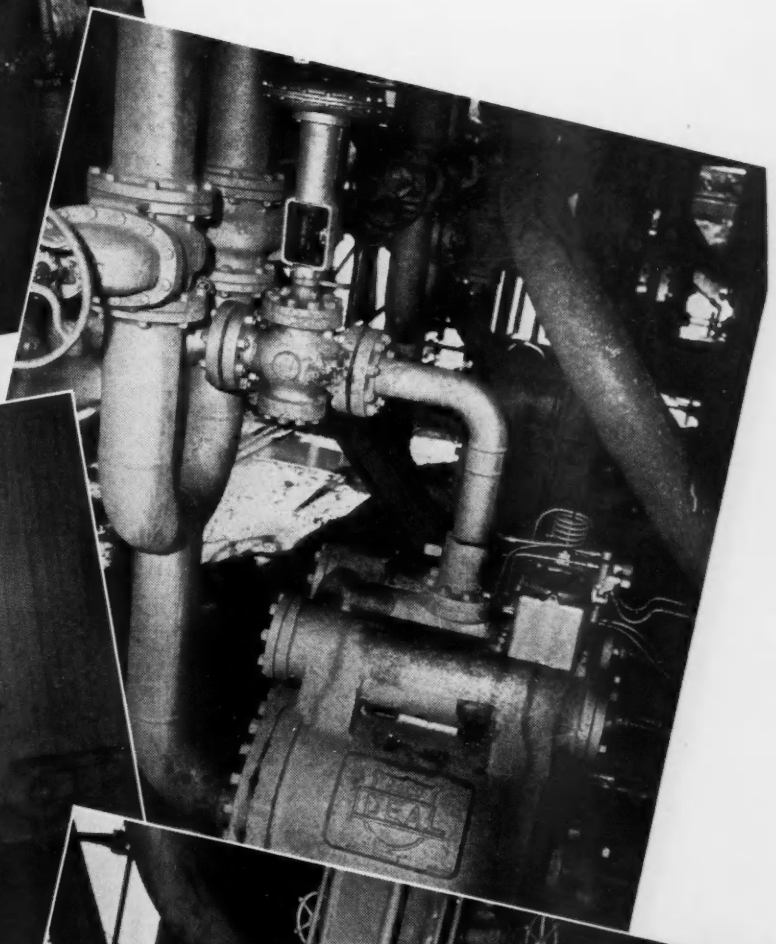
ABOVE: A mud-box with extension spout helps maintain good working space as pipe is pulled from the hole and the 135-foot thribbles are broken out. Mud thus vented is not returned to system.

LEFT: The slips are swung aside by the catline when not in use, and may be folded back on the floor, out of the way of routine hole-making. For better clearance, slips are spread flat on floor and device lowered to end of piston travel.

AIR CONTROL

LEFT: Twin compressors, mounted at one side of the barge deck, put up air for all controls. One unit operates under pressure regulation, while the other is standby for emergency use. Dual receivers insure air for all controls.

BELOW: The air control on one of the mud pumps is flanked by the dual steam exhaust system, one branch leading to the atmospheric discharge, the other to the condenser manifold.



ABOVE: The air control for the throttle on the drawworks engine is flanked by the air-operated emergency steam valve. The air-reversing unit is mounted between the cylinders, and is also push-button controlled from the driller's panel.

RIGHT: Each of the units on the main deck is equipped with an individual control such as this, so that operation may be handled on the spot for repairs or maintenance. This control supersedes that on the panel for better safeguard.

mediate transmission, incorporated in the drawworks unit, permits it to be powered with either steam engine, internal-combustion engine assembly or electric motor. An eddy current dynamatic brake is connected to the end of the drum shaft by a flexible clutch coupling.

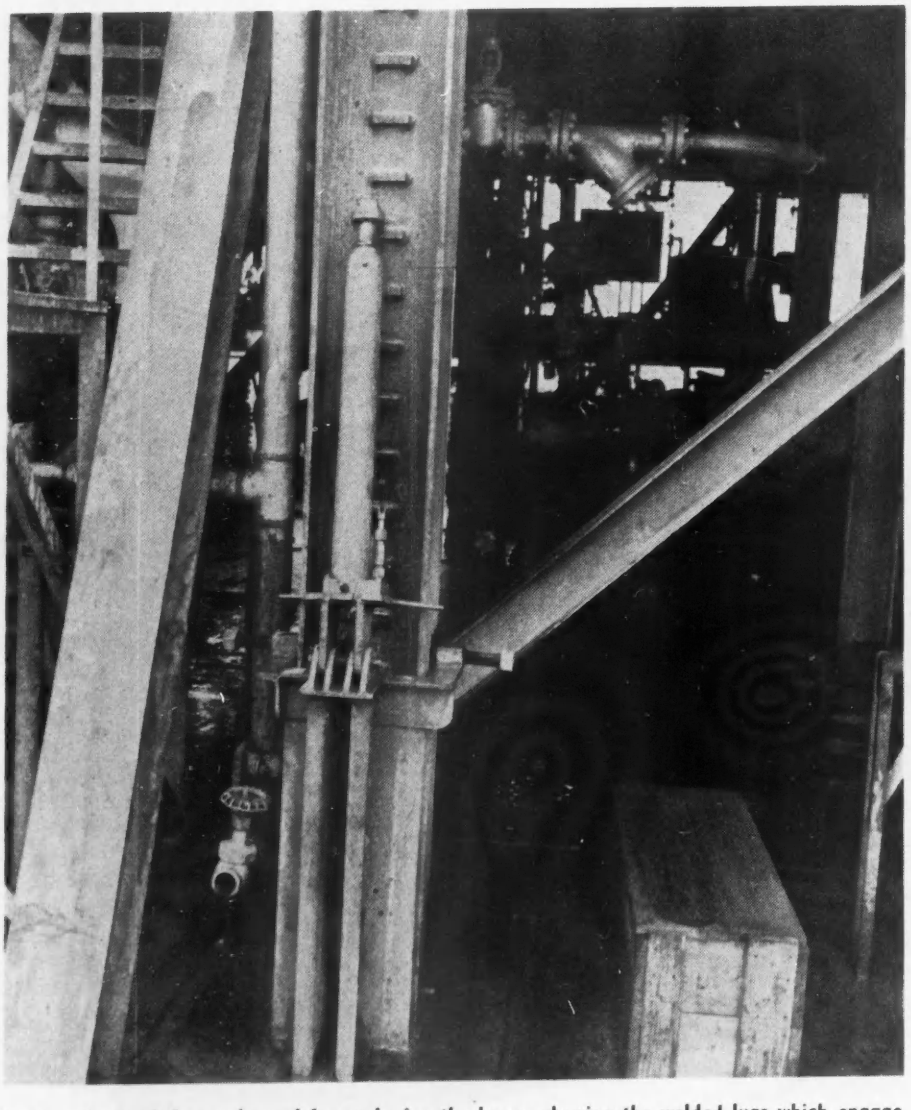
The drilling line is 1⅜-inch improved plow steel, 6x19 with hemp center, and has a nominal breaking strength of 155,400 pounds. It is bought in 3300-foot lengths and run on an eight line stringup until 12,000 feet has been passed. For completing near the 15,000-foot level, a ten line stringup is used. The crown block is a 600-ton unit, with seven 60-inch sheaves; the traveling block is rated at 500 tons, and carries six 60-inch sheaves. The dead-line anchor is a drum, mounted in the corner of the derrick diagonally across from the driller's stand, and carries three wraps of the line on its drum before the end is anchored in the lever arm which rests on the weight-indicating device. Slack for replacing line cut off at the drum is fed through this anchor and around the sheaves in the conventional manner. Spare line is stored on the reel at the edge of the pipe-racking space.

Two rubber bushed line guides are used on the live line, a third being installed on the dead line opposite the gooseneck in the standpipe.

Power Units

The drawworks on No. 7 is driven by a 16x16-inch twin cylinder horizontal steam engine, rated at 1790 brake horsepower at 350 revolutions per minute when using saturated steam at 350 pounds per square inch. This engine abuts the transmission case at the back of the drawworks. The rotary is driven by a separate 12x12-inch twin cylinder engine, located on a base slightly above the barge deck level and connected to the rotary through a special jack shaft with a cathead. The engine has a brake drum and air brake for stopping the rotary. The chain drive from jack shaft to rotary is housed and runs in oil.

The coring line reel, mounted on the main floor, has a 9x8-inch twin cylinder horizontal engine, with cathead on drum shaft extension for various types of light hoisting. The reel will handle 18,000 feet of ⅝-inch coring line. This engine has throttle control at the reel, and is the only lifting unit which is not controlled from the panel at the driller's stand.



Section of one of the spuds used for anchoring the barge, showing the welded lugs which engage the hydraulic jack for pulling the base from the marsh. The two one-inch set screws anchor the unit in place when lifted, and also prevent shifting when the spud is in working position.

Mud System

The two main mud pumps are 19x7¾x22-inch duplex with air-operated steam throttles. One is mounted on the port side, the other approximately amidships on the barge deck. A 15½x8½x20-inch duplex pump is used as standby, completing the parallel row across the barge. Either main pump will require approximately 1000 horsepower input at peak operation, when it will put up 2900 pounds per square inch pressure with a 6¼-inch liner. Mud output at that pressure will be approximately 500 gallons per minute. Transfer and circulating are handled by the smaller pump at pressures to provide adequate jetting head.

Reserve mud pits are constructed under the pipe rack to balance the operating mud pits at the opposite end of the barge. The combined pits will hold a total of 3300 barrels of mud. The two dry mud and chemical houses located above the mud pits at the after end of the barge will store 2000 sacks of material. A belt conveyor, slung from and spotted by a jib boom and hoist, transfers mud materials from the supply barges to the storage rooms aboard the barge. The rooms are provided with hoppers which are connected directly to the pits below them, insuring quick admixture with minimum handling.

Mud suction lines are brought out of the working pits below barge floor level, being accessible through heavy steel hatches which normally are closed to present smooth floor space. The lines are equipped with sleeve-type couplings, and are welded at the line where they emerge from the deck plates.

Chemical treating vats are set up on the main ditch, just beyond the shaker installation. Cuttings from the shale shaker are deposited on the shore or in shallow water alongside the barge, on the port or shore side of the installation.

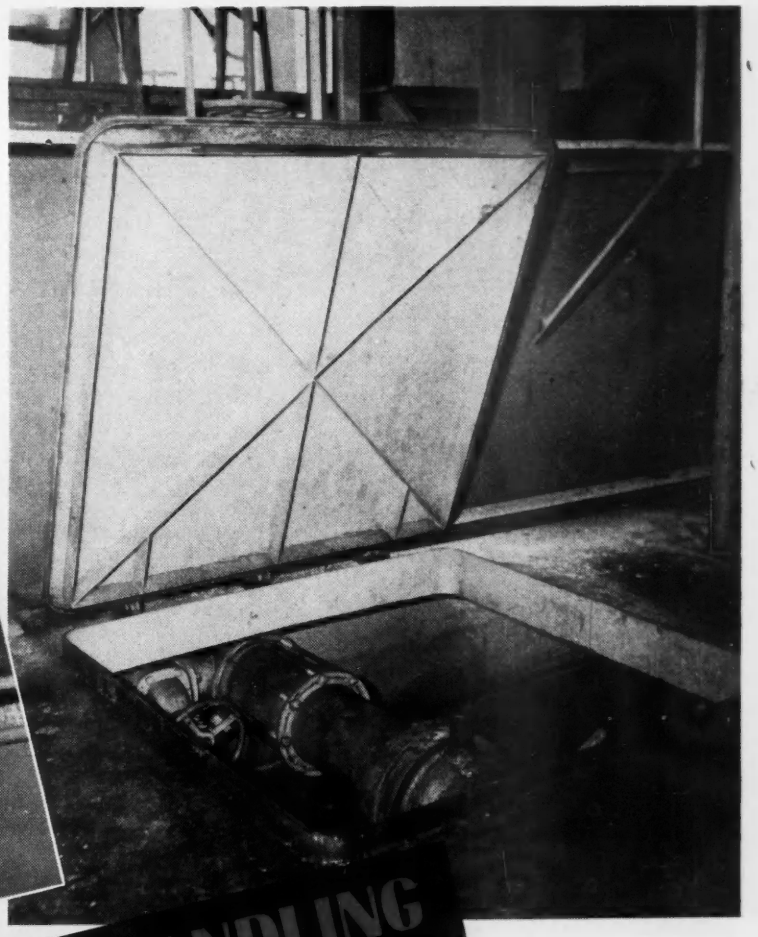
Flow openings in the bottom of the mud ditch enable the flow to be diverted to any of the operating tanks desired. The control valves are operated from the walkway which parallels the ditch.

Innovations

There are a number of new ideas and advancements which have been incorporated on No. 7. Air-operated slips are used. They may be swung into or out of operating position by the catline, and are controlled by two small pedals flanking the driller's stand. An "intercom" system is planned for communication between the driller, the derrickman and the

RIGHT: Mud lines are carried below the main deck of the barge, with heavy hatches at connections to allow checking. Expansion joints absorb vibration, and heavy flanges insure alignment.

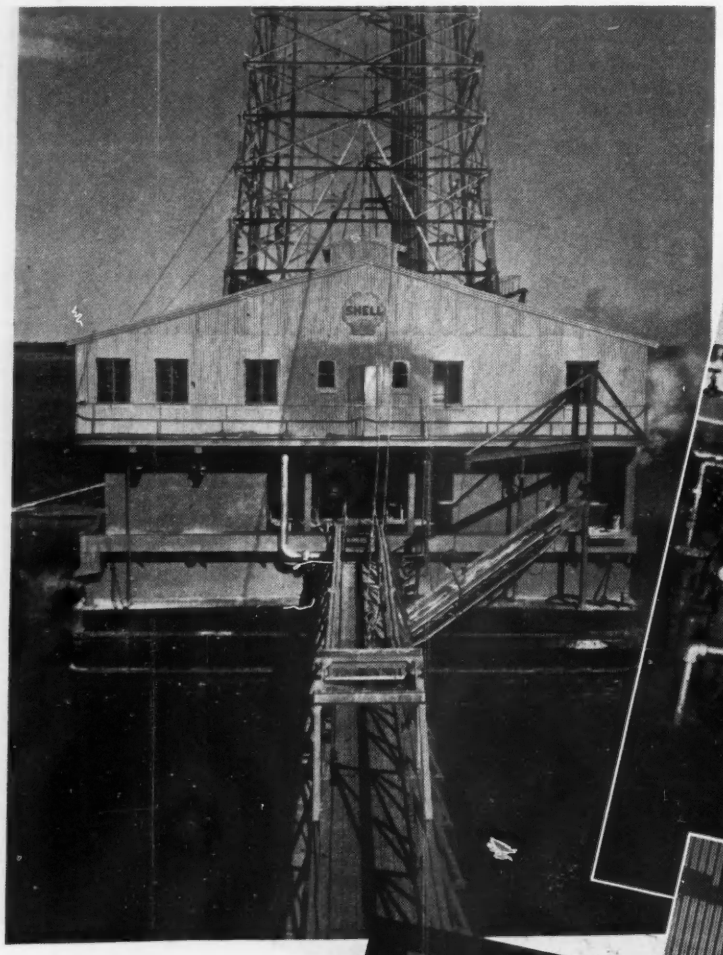
BELOW: Mud hoppers in each mud storage house allow materials to be fed directly into the mud pits through jet-operated feeders with wall-mounted control valves.



MUD HANDLING

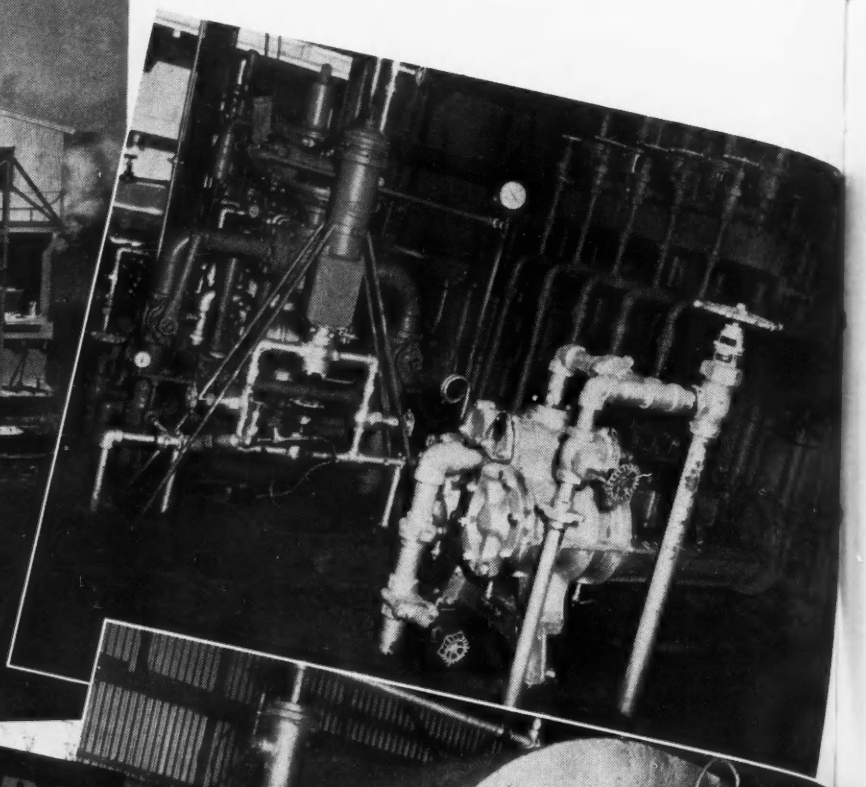
ABOVE: This pressure-type mud chemical mixer may be operated at elevated temperatures under steam pressure, and the mixture added to the mud stream flowing below it at closely controlled rates.

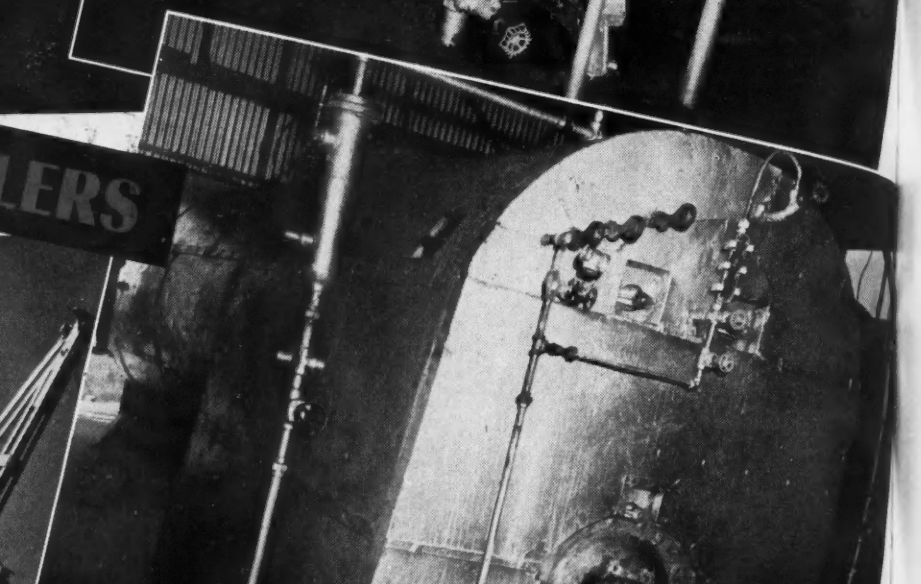
RIGHT: The mud ditch surrounds the mud storage houses, with downspouts to the various storage and working tanks. The plug-type valves are simply set into the apertures, or lifted aside for free flow.

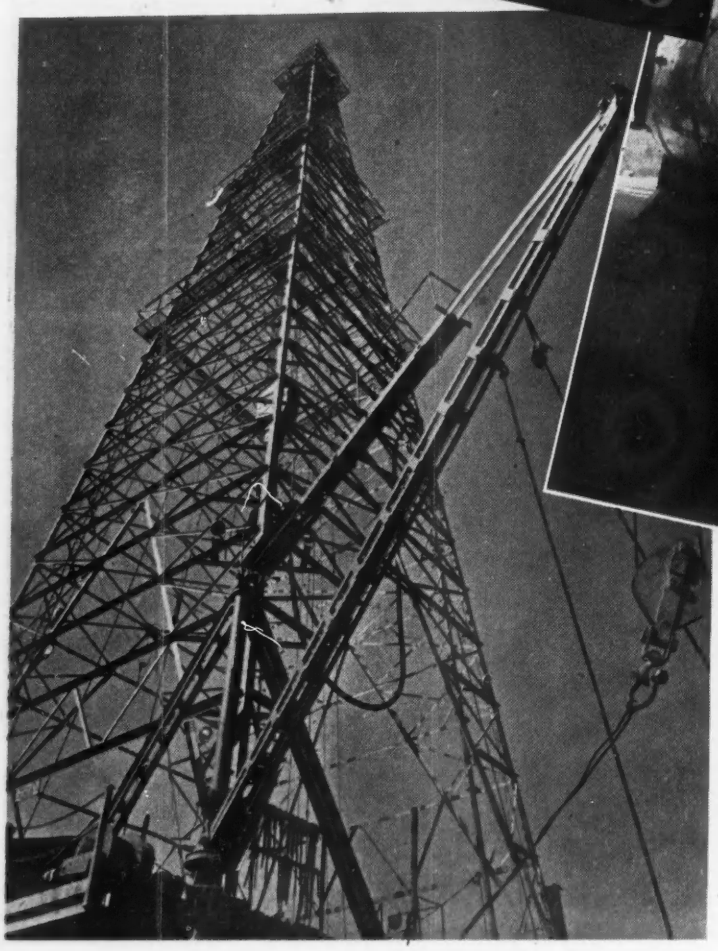


LEFT: This walkway connects boiler and drilling barges, and carries steam, air and water lines as well as power cables and intercom wires. Hinged to both barges, it may be lifted by line over derrick when shifting locations.

BELOW: The feedwater controls on the boiler barge are located between the two sets of boilers, and are automatic in action. Pump in foreground is feed-water unit, tied to manifold beyond it for distribution to five steam units.







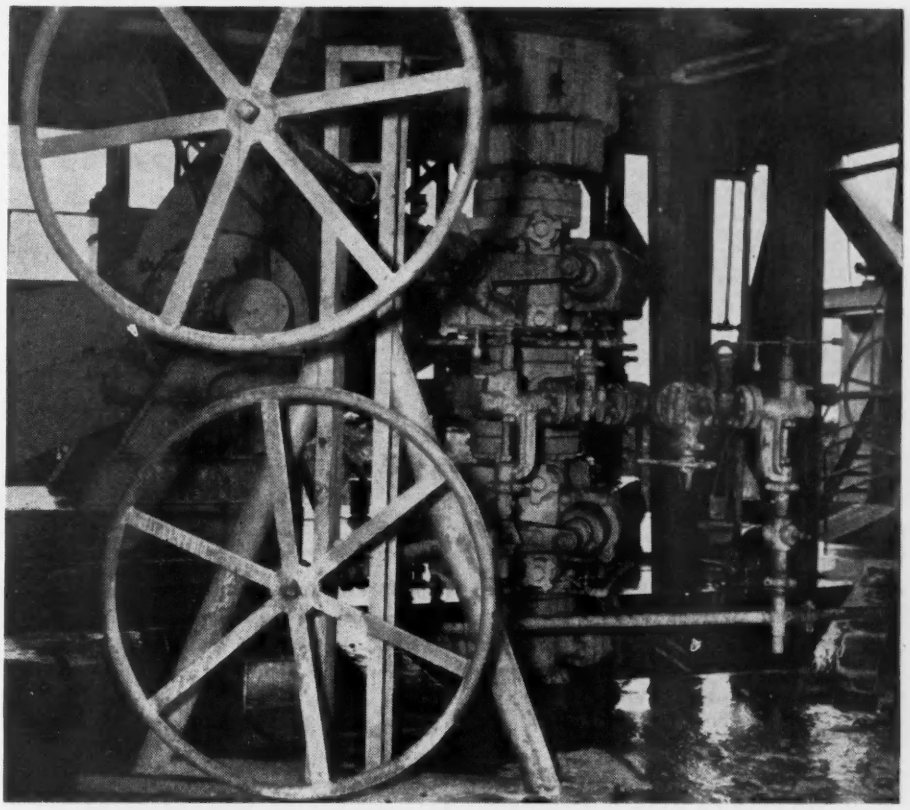
ABOVE: One of the boilers, front end view, showing sealed firedoor and blowoff connection. The column at left is automatic water level control, with forced draft unit in pit below end of barrel.

LEFT: The derrick carries a boom, powered by separate steam winch, for handling heavy equipment from transfer barges to the storage section of the drilling unit. The boom covers 30 feet of one side of the derrick, and the storage area of the pipe storage floor.

fireman. This system will permit operations to be carried on when fog or other weather conditions lower visibility and will eliminate the uncertainty of shouted or hand-signalled instructions.

A slot is cut in the upper deck of the starboard or water side of the rig to allow subs, special tools, etc., to be loaded aboard with the catline. The loading boom at the forward starboard corner of the derrick is 35 feet in length, with a capacity of ten tons. A steam winch powers the unit. A catwalk on the tension member provides access to the sheaves and hoisting line.

The upper deck, abaft and flanking the drawworks engine, has over 1000 square feet of office, galley, sleeping quarters and change room space. Sleeping quarters are provided for the tool pusher, engineers and service men who frequent the rig from time to time. A quarter boat, separate from the rig, may be used to house drilling crews when the location is difficult of access. Two large supply rooms, both on the starboard side, complete the sheltered space on the upper deck.



Manual control of the blow-out preventer rams is through this heavy unit, bolted to the lower or main deck of the barge. The power controls are to be seen in the manifold to right of the wheels, with the rotary engine to the left behind the wheels. The sloping pipe just right of the preventer assembly is the mousehole, resting in the mud below the cellar slot.

Boiler Barge

Steam to power No. 7 is furnished by five 150-horsepower boilers mounted on a submersible barge 100x34x16 feet. The boilers are operated under 350 pounds pressure, gauge. At present, based on a 300 percent rating, 2250 horsepower is available for peak operations. Provision for a sixth boiler, to increase the output to 2700 horsepower, has been included.

To minimize boiler water makeup, exhaust steam from all larger power units will be diverted into a 2000 square foot condenser mounted just below the working floor of the drilling barge and condensate will be returned to the boiler barge water storage tank. For condenser water, a close-coupled vertical turbine pump will be set in the barge to provide adequate flow of bayou water. Installation of the condenser unit is held up pending delivery of some units. Dual steam exhaust lines, for atmospheric and condenser flow, are built into the barge piping.

Feed water is heated in a deaerating unit capable of heating 60,000 pounds of water per hour from 60 to 225 degrees, Fahrenheit. Provision for chemical treatment of the water is included in the flow system on the boiler barge. A three-inch gas regulator controls the natural gas supplied to the burners. Forced draft burners are used, the fan turbines being controlled through a one-inch regulator. Draft pits are built in under the boiler shell, and firing is toward the boiler front, with the blowoff lines connected at both the back and front ends of the fire boxes.

When fired with oil, a one-inch pump governor is controlled from a volume tank to maintain a constant pressure on the burner manifolds. Oil pressure is put up by 6x4x6-inch pumps, and an oil heater is used to preheat the oil to any desired temperature up to 180 degrees, Fahrenheit, prior to reaching the burners. Four feedwater pumps are used on the barge, two being 10x6x10-inch and the other two 10x4½x10.

Throughout both boiler and drilling barges, care is taken to insulate all boilers and steam lines, and all lines and valves are carefully checked as to size to avoid unnecessary friction losses. The main steam header to the drilling barge is eight-inch, instead of the usual six-inch diameter.

A 96-foot long galvanized structural steel walkway connects drilling and boiler barges. The walkway is hinged to the drilling barge and may be raised by a line from the derrick when changing locations. Brackets on the outside of the walk hold steam and water lines between the barges.

Air Controls

Compressed air is used for control operation throughout the main units of No. 7. The panel behind the driller carries either button or small lever controls which actuate air-operated throttles on drawworks and rotary engines, as well as on the steam pumps. Each unit except the drawworks is, however, provided with a separate air valve controlling the admission of steam to the unit. This provision enables the man at any one of the units distant from the driller—and out of his sight—to operate it for maintenance or any other work. This on-the-spot control supersedes the control on the driller's panel, so as to prevent possible misunderstanding or accidental opening of a throttle valve when conditions at the power unit do not justify it. The air-operated throttles are all backed with hand-operated block valves to permit maintenance work on the controls. In addition, the drawworks engine is equipped with a dead-weight actuated emergency valve which is tripped by an air device controlled from the driller's stand. A projecting end of the trip lever at the throttle enables this valve to be released manually, if desired.

Marine Rig No. 7 represents a long stride in the application of bigger, heavier equipment that will solve problems encountered in deep drilling. Developments worked out for this marine rig for submersible barge operation are suitable or can be adapted readily to the requirements for offshore drilling, in water up to ten feet deep and thus bring successful, everyday exploration in the Gulf of Mexico closer to just another routine operation of the highly developed art of drilling.

Interpretation of *Electric Logs* In Limestone

By HUBERT GUYOD,
Well Logging Consultant, Houston

THE primary purpose of this paper is to summarize the methods of interpretation of electric logs in limestone reservoirs, namely to show how pay can be distinguished from non-pay, and how to determine a few reservoir characteristics.

Pay and Non-Pay

In electric logging work it is convenient to define pay as a formation having the following characteristics:

effective porosity,
permeability,
petroleum in commercial quantity.

On the other hand, non-pay is any formation which does not possess all these properties: for example, non fractured oil shales, water sands, etc.

Electric logs frequently make it possible to distinguish pay from non-pay. The basic method of interpretation is summarized on Figure 1.

Classification of Reservoirs

On this slide, reservoirs are classified into two main groups; the first comprises sands and sandstones, and the second limestones.

Sands and sandstones are characterized by a reasonable uniformity. An important consequence is that the interpretation of electric logs is relatively simple in these formations. On the other hand, limestones usually lack uniformity: the geometry of the pores varies within large limits over short distances. This results in a much greater difficulty in interpreting the logs.

Intergranular Reservoirs

In reservoirs having only intergranular porosity, sands, sandstones, and many limestones, the interpretation of electric logs is made basically as follows:

1. The potential graph indicates the possible pay zones, namely the formations having both effective porosity and permeability. It is well to note, however, that the data thus obtained are purely qualitative.

2. The resistivity graphs indicate which of these zones contain petroleum. In theory, quantitative determinations are frequently possible by using either one of the following relations:

$$S = 1 - \sqrt{\frac{R_w}{\rho} \times \frac{1}{P^m}} \qquad (1)$$

$$S = 1 - \sqrt{\frac{\rho_o}{\rho}} \qquad (2)$$

where S is the petroleum saturation,
ρ the reservoir resistivity,
R_w the interstitial water resistivity,
P the porosity fraction,
m the cementation factor,
ρ_o the resistivity of the reservoir when entirely saturated with water.

The accuracy with which the saturation can be estimated from these equations depends upon the accuracy with which the pertinent factors can be determined.

Possible Pay Zones

In soft formations the location of possible pay zones is relatively easy. When the potential graph swings to the left, the corresponding formation is usually both porous and permeable. The converse, unfortunately, is not always true: a possible reservoir does not always exhibit a large potential deflection to the left, as shown on the bottom left of Figure 1, which represents a sand which is probably shaly. There are cases where sand sections, cored with 100 percent recovery, do not exhibit any potential at all, or any substantial resistivity increase, even below the fresh water zone. Evidently, such sands will be passed up by the electric log.

In appraisal work it is important to determine accurately the net thickness of the reservoir. This problem is solved if the boundaries of each pay section can be determined. In soft formations, these boundaries correspond to the point of inflexion of the potential graph, and they can be picked with accuracy if the reservoir exhibits a substantial potential. If the potential is small, the corresponding pay section is frequently overlooked, which results evidently in an underestimation of the pay.

If sections of the sand do not show up at all on the potential graph, the net pay thickness determined from this graph may be grossly in error.

To summarize, in soft formations net sand thicknesses given by the potential graph may be correct, but may also be less than the actual figures.

In intergranular reservoirs associated with hard formations the potential behaves in a different manner. Every petroleum engineer is familiar with the peculiar shape of the graph. Any potential graph can nevertheless be explained simply by remembering that bore hole potentials are caused by an electrochemical chain comprising shale, mud, formation water, and by investigating the potential drop in the section of this circuit constituted by the mud column. When the reservoir is surrounded by shale only, the current set up by this chain follows simple paths and the graph exhibits the

THIS PAPER is a summary of a talk given by the author on January 10, 1947, before the Petroleum Engineers' Club of Dallas at the suggestion of the firm DeGolyer and McNaughton, following a conference on this problem with their engineers and geologists.

Inasmuch as some of the ideas expressed by the author have some bearing on the discussions offered in the current series on "Electrical Logging Developments in the U.S.S.R.," it has been thought desirable to publish this summary for the benefit of WORLD OIL readers. Part 4 of Guyod's series, "Electrical Logging Developments in the U.S.S.R.," will appear in the April issue.

familiar shape shown by the log to the left. But when the pay is associated with tight, non-conductive beds, the currents associated with the electrochemical chain must follow unusual paths, which results in unusual potential graphs.

Referring to the center log of Figure 1, it can be seen at A that if a very tight formation is comprised between the reservoir and the overlying shale, the potential starts increasing opposite the tight section. In this case the point of inflexion previously mentioned is replaced by a straight, but inclined, section of the electric log. Picking the upper pay boundary at the mid point of this section evidently would set the formation top too high and would result in an overestimation of the pay.

A similar remark can evidently be made if a hard streak is situated below the reservoir, as shown by Figure 3.

Conversely, if a potential graph exhibits a straight inclined section, this is an indication that there is a non-conductive material, namely a tight formation, between a shale and a formation having intergranular porosity. This remark is extremely important in appraisal work because it furnishes the key for determining the net pay thickness. Contrary to what is found in soft formations, errors of interpretation would result if all the zones exhibiting an increase in potential were considered as being possible pay.

When the tight zones contain a few shales or some fractures, even thin, the potential opposite most of the tight section usually drops to the right hand side base line values, as shown in the intermediate section of the middle log.

In short, in intergranular reservoirs, associated with very hard formations, the pay thickness may be overestimated if the electric log is not carefully understood and interpreted.

Finally, in fractured or cavernous reservoirs the potential graph is extremely misleading, and generally useless. Use of this graph for estimating the net pay thickness will usually lead to values which may be either too high or too low.

Two Types of Wells

Wells can be classified into two groups, exploratory wells and field wells.

The problems to be solved in these two types of wells are not the same. In the first case, we are primarily interested in discovering a petroleum reservoir. Any reservoir is welcome, whether its net thickness is ten feet or 100 feet, or whether the petroleum saturation is 70 percent or 85 percent. Conventional electric logs are well adapted to such qualitative determinations because they give data which can be broadly analyzed.

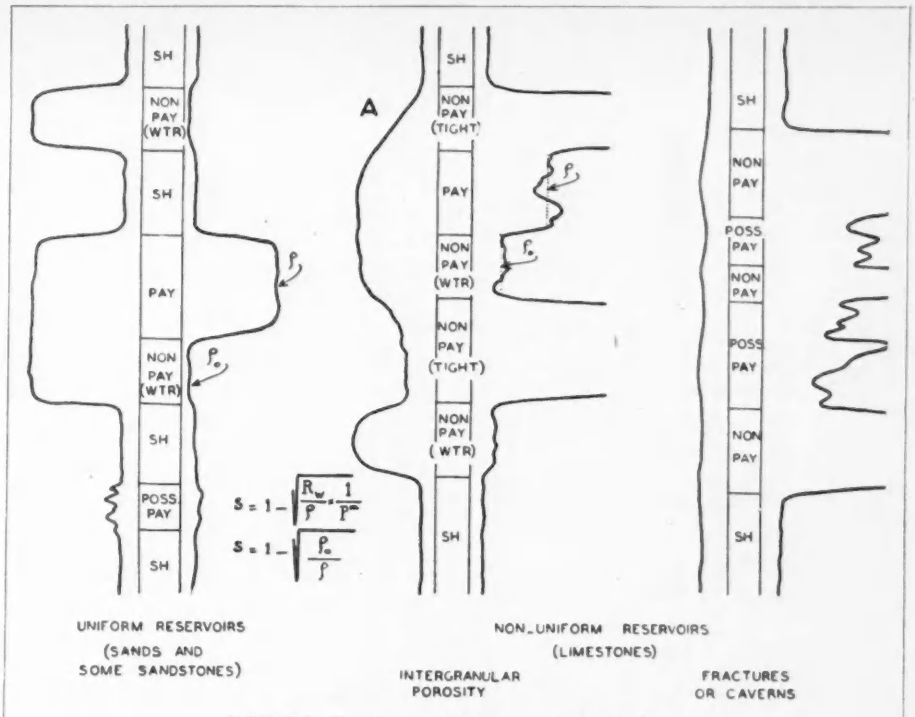


FIGURE 1. The three typical types of electric logs.

On the other hand, in the case of field wells the reservoir is already discovered. We are interested in securing as much and as acurate information as possible on the reservoir characteristics. Conventional electric logs usually are not so well adapted to this problem because they do not take advantage of the data already at hand, in particular type and geometry of the reservoir. Conventional logs have been so standardized that, in my opinion, they have not permitted a good development of certain applications of electrical data. Nevertheless they are of great value in many instances.

Exploratory Wells

Intergranular reservoirs. If all the factors contained in the right side of equations (1) or (2) were known, then the petroleum saturation could be determined rather accurately from electric logs in reservoirs having intergranular porosity.

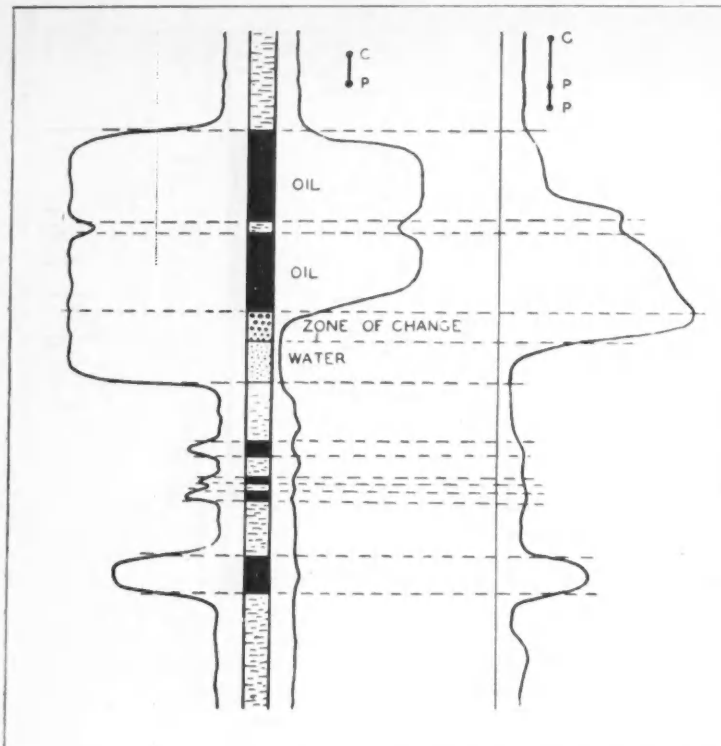
In the case of exploratory wells, these factors are never known with certainty, except possibly the resistivity. However, in the case of most sands and of certain limes, reasonable assumptions can be made because these formations are rather uniform and their characteristics do not vary widely over short distances. For instance, if the reservoir is very easy to drill, then it can be assumed that it is not cemented, and that its porosity is large. This gives approximate values for the factors P and m. In such reservoirs, the resistivity generally is not very high and can be determined from the electric log, with or without correction. Finally, if a known salinity trend exists for the interstitial waters, the term R_w can be estimated with fair accuracy. In other words, the factors of equation (1) are frequently known, or limiting values can be set, and it is therefore sometimes possible to tell from an electric log whether a formation contains a commercial saturation.

The problem is still easier if the well has been drilled below the edge water level, as shown in Figure 2. In this case the log gives ρ and ρ_o rather accurately and equation (2) permits determining the saturation without the necessity of securing additional data.

In the case of many limestones the interpretation is more difficult because of the presence of tight zones. These zones distort the resistivity graphs, which prevents calculating the true resistivity. This evidently renders impossible the use of equation (1) or (2) for determining the reservoir saturation.

Fractured reservoirs. Equations (1) and (2) do not apply to fractured reservoirs. No other similar relation involving the saturation is available at present. Therefore, the electric log cannot give, even roughly, the petroleum saturation. The log is used mainly for picking the possible pay zones, namely sections having low resistivities. These generally indicate fractured zones, or shale beds. Whether the fractured zones contain petroleum cannot be determined from the log. An example is shown to the right of Figure 1.

Another limitation of the electric log



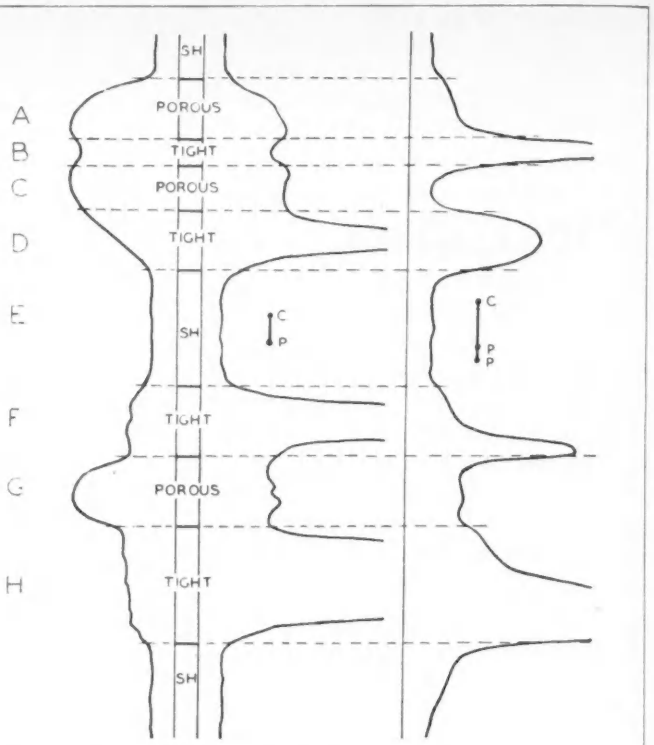


FIGURE 2 (left). Interpretation of electric log in soft formations. Dash lines indicate formation boundaries.

FIGURE 3 (right). Interpretation of electric log in intergranular reservoirs associated with hard formation. Dash lines indicate formation boundaries.

is that it fails to indicate pay zones lacking good effective porosity at the time the log is run. These zones, logged as non-pay from electric data, may become productive after shooting or acidizing.

Field Wells

In these wells the problem is somewhat different because the pay is already discovered. If an adequate electric log is available it is possible to estimate the net pay thickness and the saturation of many reservoirs. Referring for example to Figure 3 the pay zones are determined as follows: Zones A, C and G showing a fair resistivity and a rounded potential are porous. Zone B having a very high resistivity and a little potential depression is a tight zone with perhaps very thin and few shale breaks and/or fractures. Zone D having a very high true resistivity and a potential exhibiting a straight slope is a solid tight zone. Zone E is evidently a shale. Zones F and H having a very high resistivity but a rather indefinite potential are primarily very tight zones with a few thin streaks. These streaks may be shales, fractures, or even intergranular lime. It is impossible to tell which from the log. If additional adequate graphs were available, a more accurate net pay thickness determination might be possible.

As explained before, it is impossible to estimate the petroleum saturation from an electric log unless the true resistivity can be determined. In field wells, the geometry of the reservoir is approximately known beforehand. It would therefore be a simple matter to use electrode arrangements giving data from which the true resistivity could be determined with the maximum chance of success. This, unfortunately, is not generally done, which often results in logs which are poorly adapted to the formations concerned.

In field wells, occasional formation samples are usually available, as well as formation water. This permits determining the factors R_w, P, m and ρ_o of equations (1) and (2). If the reservoir is reasonably uniform, the data can be assumed to be representative of certain zones over large vertical and lateral distances. In field wells, it is therefore possible to estimate from an electric log the saturation of many formations. It is claimed that these estimations are frequently more accurate than core analysis data.

In reservoirs which are very non-uniform, the foregoing method generally cannot be successfully applied unless extensive coring is used, and unless the electrode arrangements are carefully selected. Because of these limitations, petroleum engineers do not rely much on electric logs for obtaining saturation data in non-uniform reservoirs.

Conclusion

Electric log interpretation is difficult in limestone formations. This is due to two main reasons:

1. The potential graph has to be analyzed much more carefully than in sand reservoirs. In particular, one has to remember that an increase in potential frequently indicates a tight formation.

2. The resistivity graph is much distorted by the tight zones associated with the reservoir. This frequently prevents determining the true resistivity, i.e., the petroleum saturation.

It is obvious that nothing can be done regarding the interpretation difficulties of the potential graph, except analyze the data adequately, using the equivalent circuit analogy.

Regarding the resistivity data, the interpretation difficulties can be minimized by running adequate electrode arrangements and eelctrode spacings if the standard ones are unsatisfactory.

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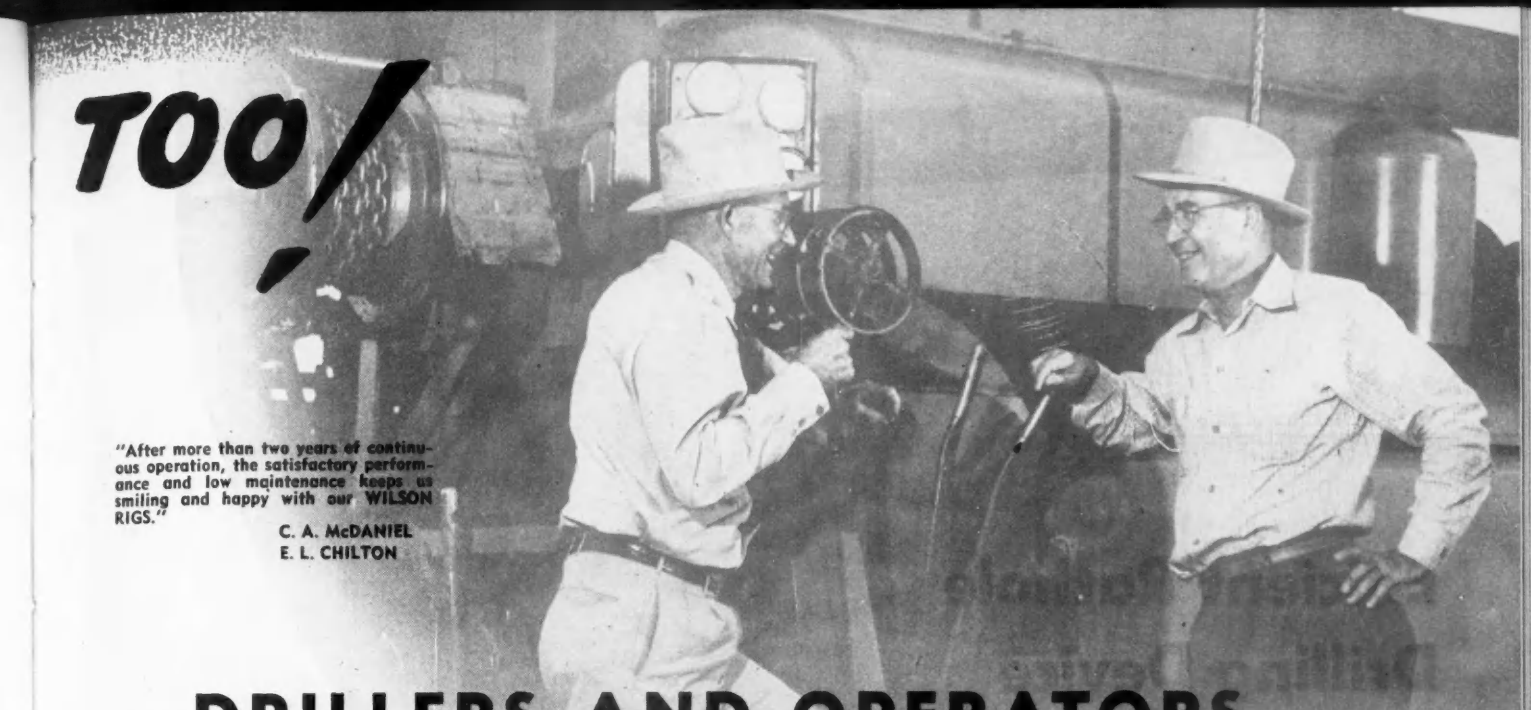

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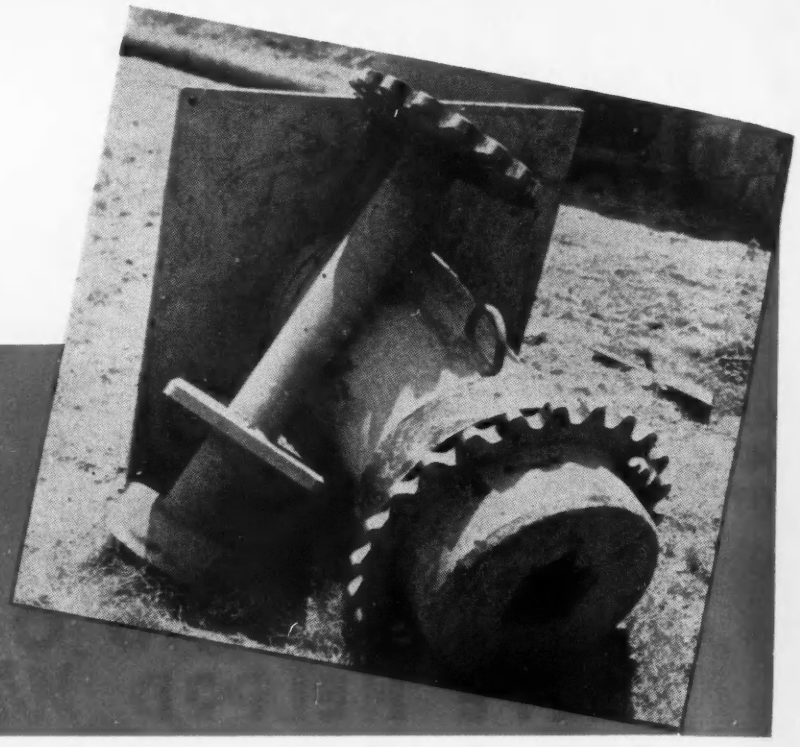
Efficient Rathole Drilling Device



By GILBERT M. WILSON
Staff Writer

DRILLING the rathole is an operation that often requires considerable make-shift arrangements such as the shifting of the rotary table, propping it so the hole will be drilled at a slant, then rigging up a chain drive between it and the rotary drive sprocket on the drawworks.

Various modifications of this procedure are employed by operators and drilling contractors. In some parts of the country, particularly in certain Rocky Mountain and West Texas fields which have lime or hard sandstone formations from the surface down, the rathole drilling operation may require considerable time, sometimes amounting to an entire tour. When location after location encounters the same problem, it is to the advantage of the operator to utilize some system which will get the job done efficiently and with a minimum of disruption of normal rigging-up procedures. Solving much of this problem is the unique equipment employed by one company which is easily installed, is sturdy enough for any job, and which can be removed from the rig floor when the rathole is drilled.

The device, shown in the knocked-down condition in the accompanying photograph, consists of two principal parts: the table, which is set up over the rathole, and the drive shaft spindle, which is set up vertically in the well of the regular rotary table. Through a sprocket-driven rotary chain, rotary motion from the spindle in the table is transmitted to the rathole table, the latter being tilted to produce the desired slope of the hole.

Simplified Rotary Bushing

The small table, measuring 37 inches high, is made up of a length of 16-inch outside diameter casing which is welded to a three-foot square base of three-fourths-inch steel plate. Holes drilled along the outer edge of this base plate permit the unit to be lag-screwed to the derrick floor. The upper portion of the table, a sleeve which projects down inside the collar on the outer shell, has as a drive a split bushing around which is welded the split sprocket. Designed, and having a cut-out for a square kelly, the top plate is of one-inch steel, sufficiently thick to drive the kelly without deformation of the plate edges. Two bolts, passed through matching ears on either side of the drive bushing, permit the opening of the table for insertion and withdrawal of the bit. Eyes welded to the side of the outer pipe section facilitate picking up or handling the unit with derrick high-line.

The driving sprocket, or spindle, consists of a three-foot length of drill pipe to which, at the upper end, is welded the drive sprocket, and at the lower end, a piece of round, ten-inch diameter by 3½-inch thick solid steel plate. About one fourth of the way up from this solid piece, a square plate of one-inch material is welded to the shaft. This plate is cut to a size that will allow the device to fit exactly inside the kelly bushing hole in the rotary table. The round solid portion extends farther down into the hole in the table, its function being to hold the unit upright and lend stability.

Following the setting up of these two pieces of equipment and connecting the two sprockets with rotary chain, drilling of the rathole can begin. No additional or complicated drive connections need be taken off the drawworks, and kelly speed can be regulated merely by manipulating the rotary table throttle. When the hole is completed and cased, the chain and drive spindle may be removed and regular drilling then started almost immediately, with no changing over of equipment, and while the rathole table is being removed and racked outside. Comparatively inexpensive to build, this simple two-piece unit is easily handled and stored when not in use, and can be used on numerous wells without suffering appreciable wear.

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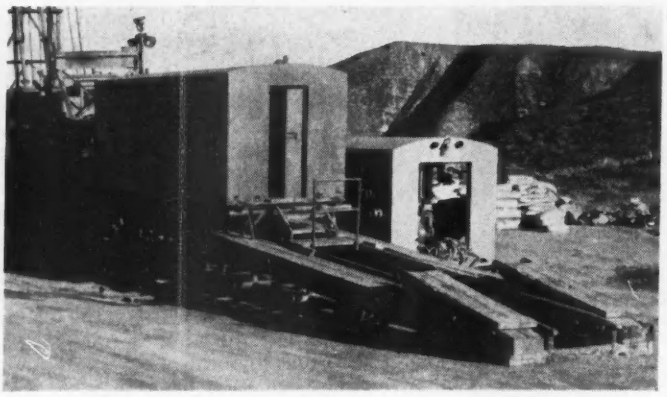
DRILLING HINTS

$10.00 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

How To—Conserve Space on Hillside Locations

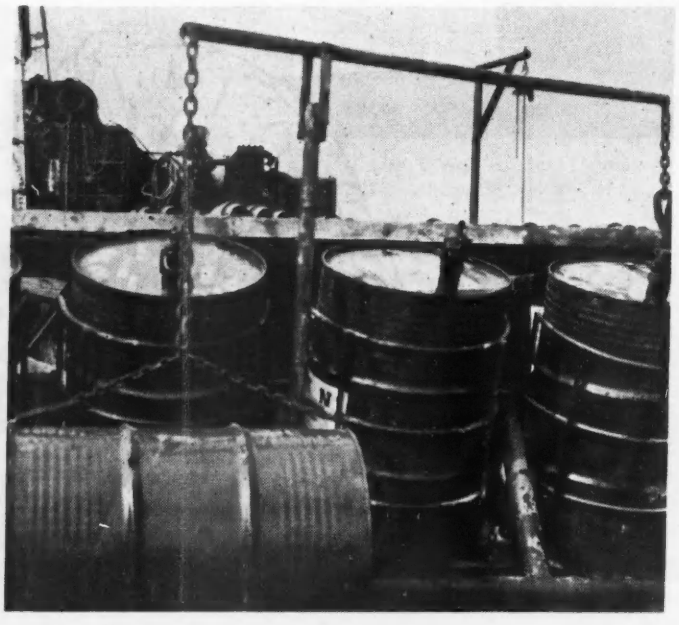


In an effort to conserve space on the hillside type of location, one operator employs a combination ramp and platform system which materially reduces both initial grading costs and rigging-up time. A long sloping ramp of all-welded, re-inforced pipe construction was built and which serves both as a ramp up which equipment can be hauled, then serves as an elevated platform upon which the steel dog house can be placed.

Located at the higher end of the ramp, the dog house is brought up level with the aid of a steel horse which is set beneath the lower end. After all equipment and house are set up the lower five feet of the ramp ends may be detached and laid up on the main sections, as shown, to provide additional yard space.

This type ramp and loading system is especially desirable in mountainous regions where wells generally are spotted on the sides of steep slopes, and where a long narrow location is considerably cheaper than a semi-circular one which would require excessive cutting away of banks.

How To—Facilitate Handling Heavy Drums of Gasoline, Oil, Etc.



Drums of lubricating oil, cleaning solvents and diesel fuel can easily be handled and placed on the dispensing rack by one man when a "helper" as illustrated is employed. This device made it possible to unload heavy drums from trucks without having to dump them from the truck bed.

The "helper" consists of a lever arm supported by a section of 2½-inch pipe of a sufficient height so the drums could be maneuvered into the dispensing rack by one man. Several sockets of three-inch pipe nipples were welded in a vertical position at strategic points on the drum rack. These sockets provided a base into which the upright supporting member of the lifting device could be placed. At the top of the vertical pipe, two pieces of ½-inch strap steel were welded to form a bracket in which was bolted the 2½-inch pipe lever.

Distance from the pivot of the lever to the shorter end is less than a third the distance to the long end, thus providing more than a three-to-one leverage. At both ends, a chain was attached. To the lifting end or short end was also added a pair of drum lift clamps to simplify tying on to the drum. The complete unit is light enough so that one man may lift it from one base and place it in another base.

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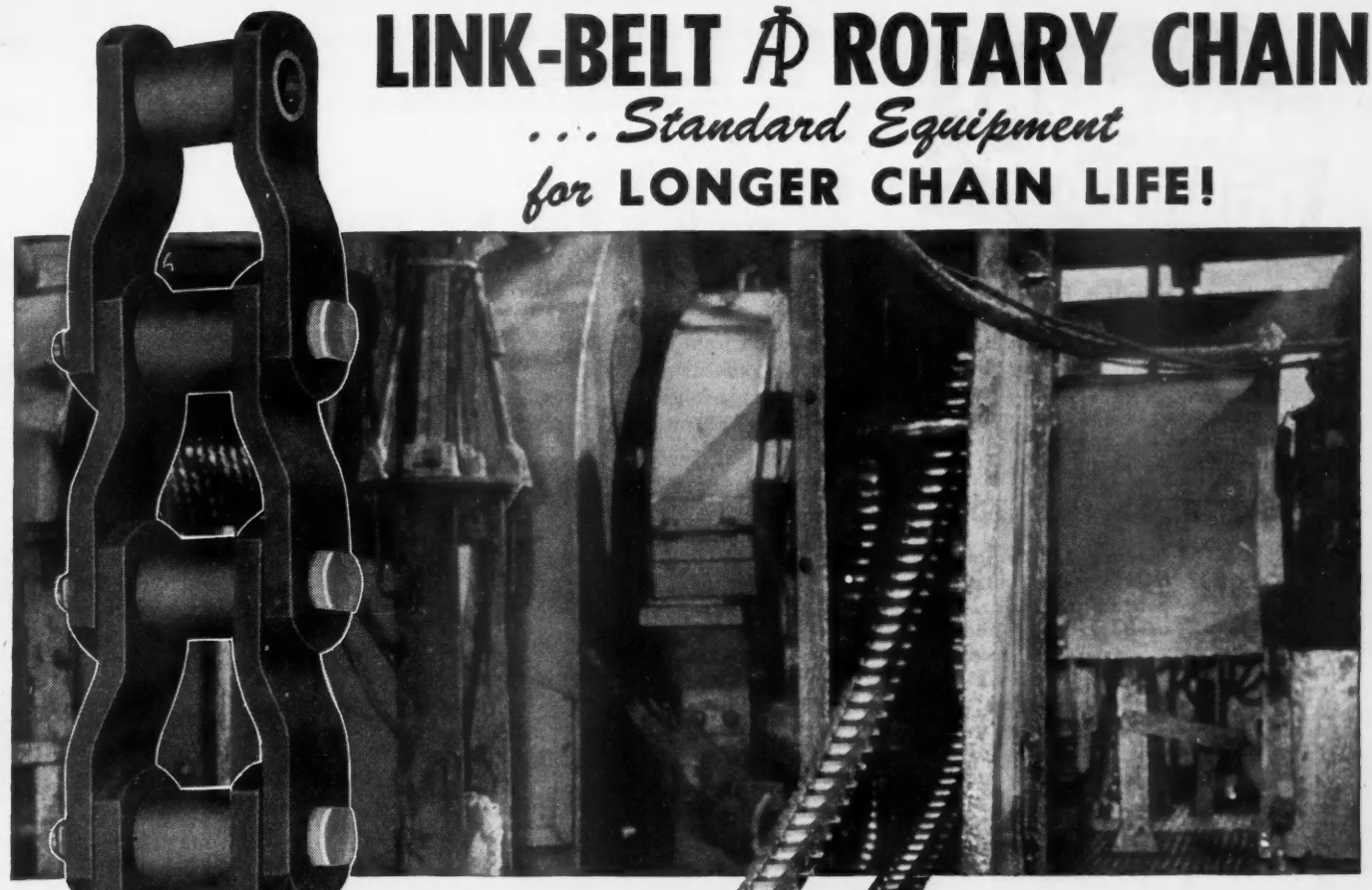
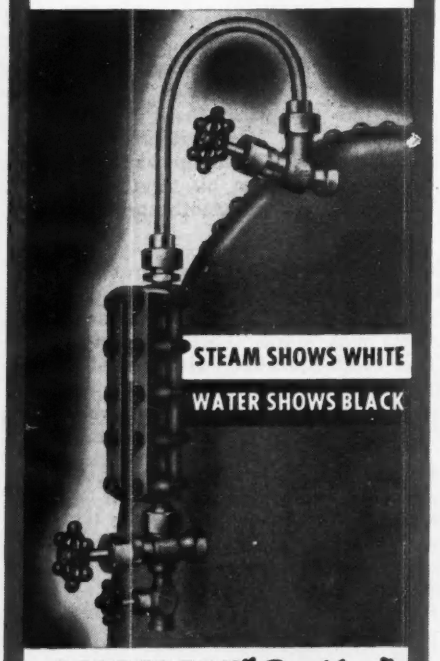


PENBERTHY Drilling Hints

Drilling contractors have long found that it pays to standardize on Penberthy products because of their exceptionally rugged construction and their dependable performance under the most severe operating conditions.

PENBERTHY INJECTOR

Penberthy Automatic Injectors are the accepted method of assuring an uninterrupted supply of feed water to boilers at minimum cost. They are quickly and easily installed—require little attention.



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Water level cannot be misread because steam always shows white and water black. U-Bolt construction permits replacing glass by simply removing nuts on face of gage... unnecessary to work between gage and boiler. 3277-D

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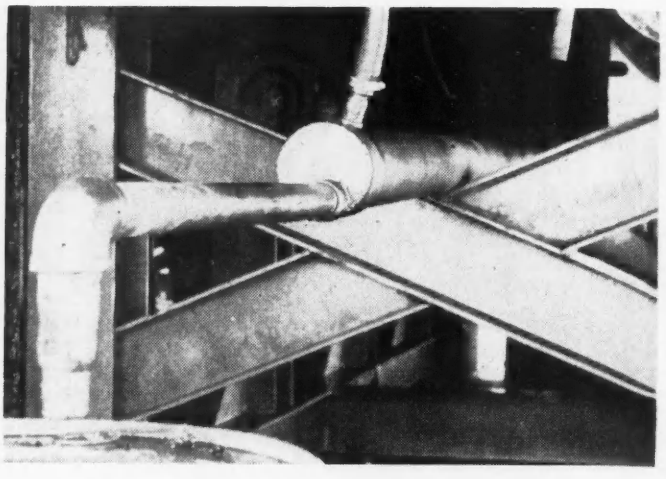
How To — Drain Crank Case Without Spills



A six-inch joint of pipe set on the diagonal braces of the substructure beneath the crank cases of the drilling engines can be used to dispose of crank case drainings. Each end of the pipe is closed with a flat welded head, and holes cut on the upper side in line with the drain plugs on the engines. The outer end of the pipe has a collar welded in the head to attach a two-inch line to transfer the drainings to a barrel for disposal.

When draining a unit, an oil-resistant hose with fittings is attached to the drain plug opening at one end and into one of the holes of the six-inch header at the other. To prevent small spills, the outer end of the two-inch line is fitted with an ell and nipple loosely threaded so the open end can easily be turned up so oil will not run out while barrels are being changed.

How To — Fasten Kelly in Housing During Moves

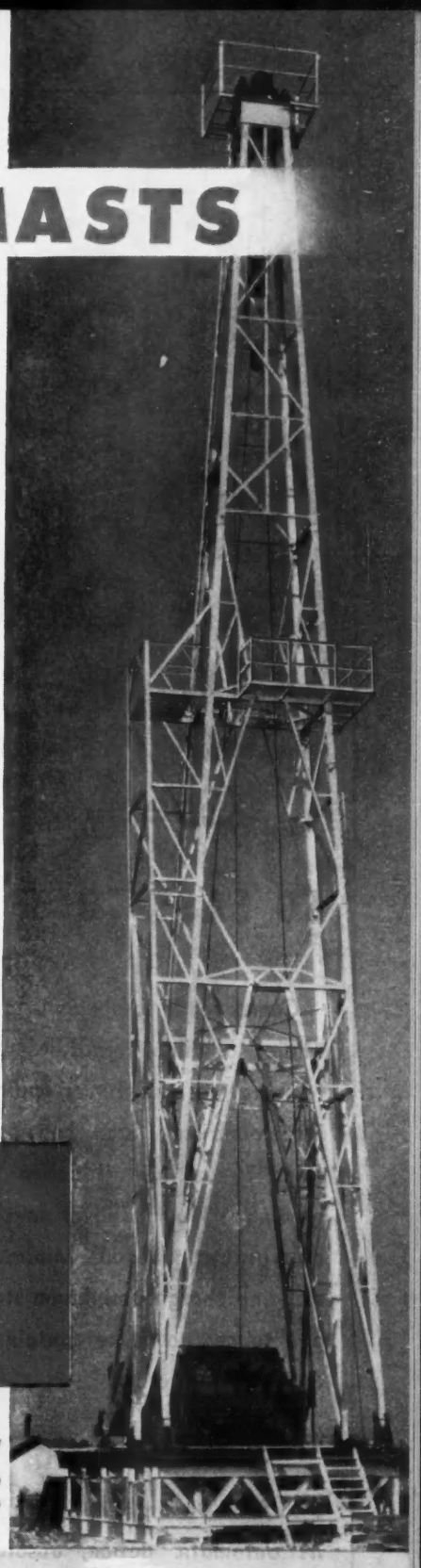
The advantages in transporting the kelly inside the rathole casing has long been recognized. Not only does this method afford protection to the kelly, but it simplifies the problem of handling long sections of equipment. Illustrated is one of many unique methods of securing the kelly inside the rathole casing so it will not slip out and cause damage or injury.

The tool pusher designed this particular holder which employs a set of flanges. To the top lip of the rathole casing was welded a discarded flange. Near the box end of the kelly, a flat circular piece of ½-inch plate steel was welded as shown. Diameter of this piece was the same as that of the flange on the section of casing, and it also contained holes which matched the flange.

In shipment from one location to another, the kelly bushing was removed, and the kelly inserted into the rathole. Four flange bolts were inserted through the flange and the circular steel plate welded to the kelly. These bolts were tightened to prevent any movement of the kelly inside the housing. Installation of the flanges is an easy job, and little time is required to prepare the kelly for moving.

EMSCO PORTABLE MASTS

Bolted & Galvanized for Export Service



Emsco's new PE series portable masts are engineered for export service. Special bolted construction reduces shipping costs 80%! Hot dip galvanizing of entire mast affords permanent protection against corrosion. Emsco export masts have all features of Emsco domestic bulge type units for fast, safe, cost-saving development of remote, inaccessible fields.

Today's widespread field operations frequently require portable drilling equipment. In foreign fields, however, the use of portable masts has been restricted by high costs involved in water transport of the large, cumbersome mast sections. The new Emsco PE series of export portable masts solve this problem. These new masts are assembled from small welded sections which are bolted together. These small sections are designed to provide a substantial reduction in shipping bulk. A complete 94′, 12 PE mast boxed for export measures only 5′6″ x 5′4″ x 40′8″—one-fifth that of a standard domestic mast. These compact, easily handled units reduce shipping costs 80%! The sturdy, compact box permits loading in hold of ship. Thus, the entire mast is protected against rough handling and the weather during water transport. Also, the lumber used for boxing frequently can be profitably reused for field erection of tool sheds, etc. Small welded sections permit hot dip galvanizing of entire mast. This means permanent protection against corrosion and greatly reduced maintenance costs. After export mast is originally assembled in the field, it is moved and operated like a domestic unit. These new export portable masts incorporate all field-proven features of Emsco standard bulge type masts. They are available in 94, 129 and 136 foot heights with crown block capacity ratings in excess of 400,000 lbs. Ask your nearest Emsco representative for information on the PE series of bulge type portable masts—the newest addition to the Emsco line.

See the new Emsco export portable mast on display at the International Petroleum Exposition, Tulsa, Oklahoma, May 15 to 22, 1948

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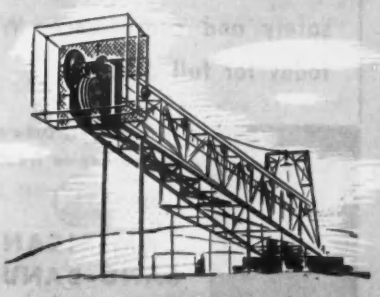

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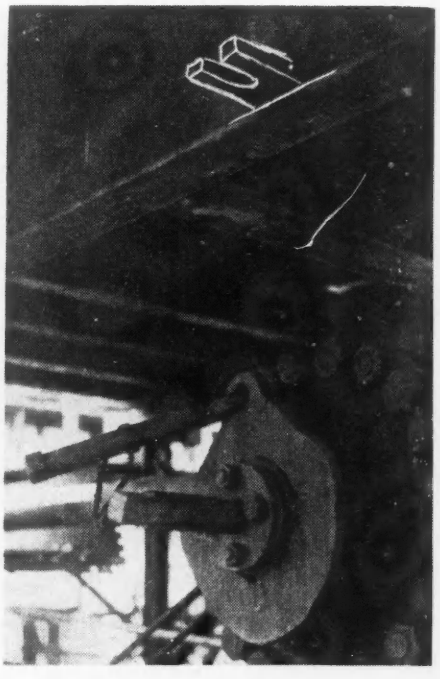
How To — Support Blowout Preventers

Equipment used on barge drilling rigs is normally of a semi-permanent nature in that it remains in one position most of the time. However, in the case of well head equipment such as blowout preventers, this equipment must be removed to make room for the Christmas tree when the well is completed, and is not used again until the surface pipe has been set on the next well.

The problem of handling these heavy pieces of equipment was solved in a rather unique manner by overhead supports attached to the derrick floor I-beams. When in use, the blowout preventer rested in such a position that the outboard tips were immediately below the 24-inch I-beams supporting the rotary table.

A rough flange was cut with an acetylene torch from a piece of ¾-inch plate steel so that it fitted over the packing gland on the operating stem. It was then tack-welded to the body of the preventer as shown. The top side of the flange was drilled for an eye which accepted a long one-inch bolt bent at right angles near its head. The take-up element on the support was a threaded sleeve which was screwed on to two bolts, one to either end.

A "U" bracket was then bolted to the heavy I-beam above and in alignment with the eye in the flange. When it became necessary to remove and store

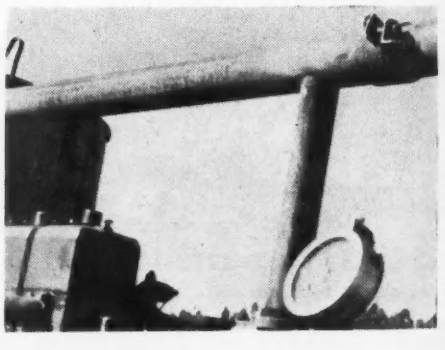


the preventer, this bolt was unscrewed until it could be placed in the "U" bracket. Slack was taken up until a strain was taken, while at the same time a similar device on the opposite side of the preventer is also being tightened. Once free, the preventer is pivoted by one of the supports while the cat line is used to maneuver the preventer out of the way.

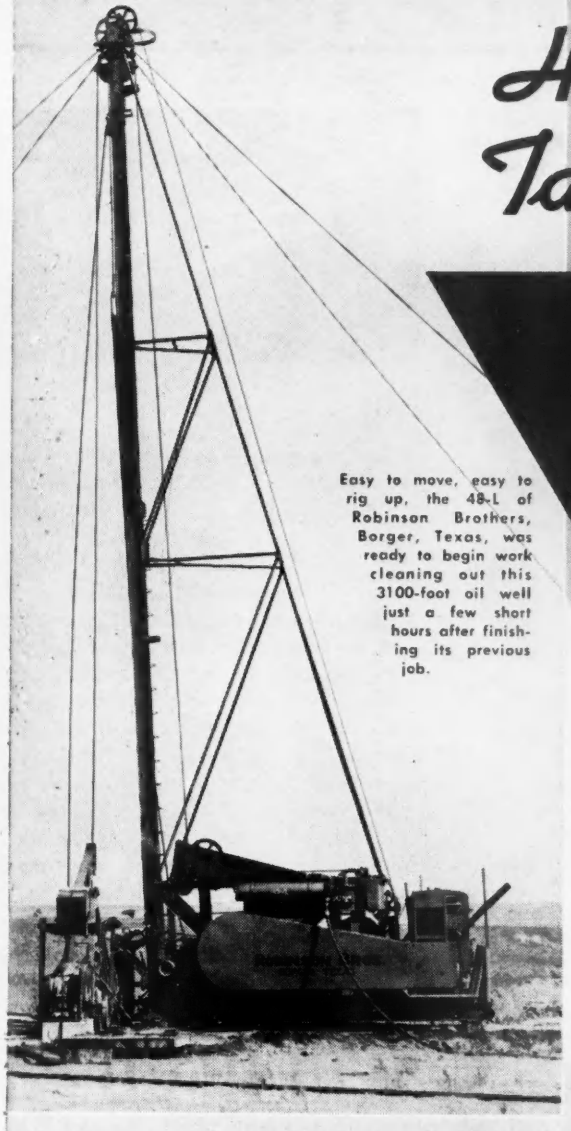
How To — Make Quick Coupling for Exhaust Pipe

Erection and disassembly of the exhaust piping to the engines driving the drawworks and mud pumps can be facilitated by application of a home-made coupling as shown. The device is a friction grip coupling held in position by two sets of lugs bolted together.

The male and female threads of the exhaust pipe joint are cut down with a lathe so they make a snug fit. Short pieces of angle iron are welded to opposite sides of the pipe coupling and the end of the pipe, and are drilled to provide matching holes. No pipe wrenches are required to make up this joint which is tight enough to prevent excessive leaks. The pipe is supported so that no strain is placed on the coupling. By using two bolts, the coupling can be made up or broken apart with little time required.



How Long Does It Take You To Move?



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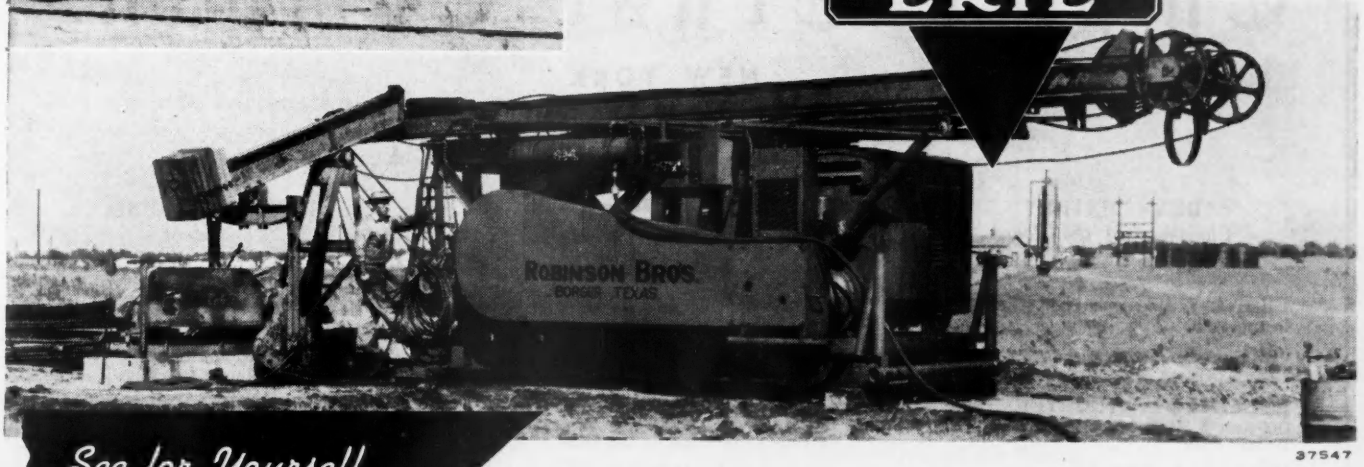

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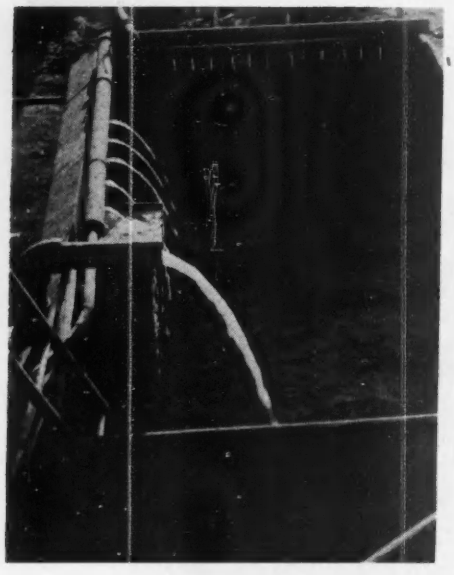
How To—

Cool Brake Fluids

In order to obtain more efficient cooling of water which is circulated through cooling systems of the hydromatic brake and other units on the rig, one company employs a sprinkler system which is mounted around the edges of the reservoir tank.

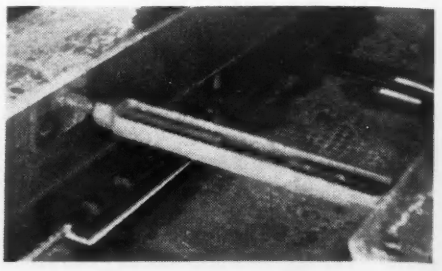


Coming from beneath the rig floor, the small circulating line enters a larger line mounted on the tank and which is perforated with small holes directed out toward the center of the tank. Water entering the system is distributed around the sides of the tank. Squirted out into the air, the coolant gives up much of its acquired heat as the stream breaks and falls into the reservoir. Set up beside the derrick, the rectangular tank is equipped with inward-sloping reinforced rim, and is designed to withstand the rough handling that comes with hauling operations.

How To—

Adjust Engine Setting

Engines can easily and quickly be adjusted to the required distance apart when rigging up by using turnbuckles between the skid members. The threaded section on each end of the turnbuckle is welded to a heavy square piece of steel drilled at each corner for machine bolts. These pads are attached to the skid members near the front end of side-by-side units. If only two engines are operated, a single turnbuckle is sufficient. If four engines are set on the floor, three turnbuckles ties the battery solidly together. By running the turnbuckle in or out, the exact distance between the skids can be obtained and the units prevented from shifting out of line by being solidly tied together at the front end of the skid bases.



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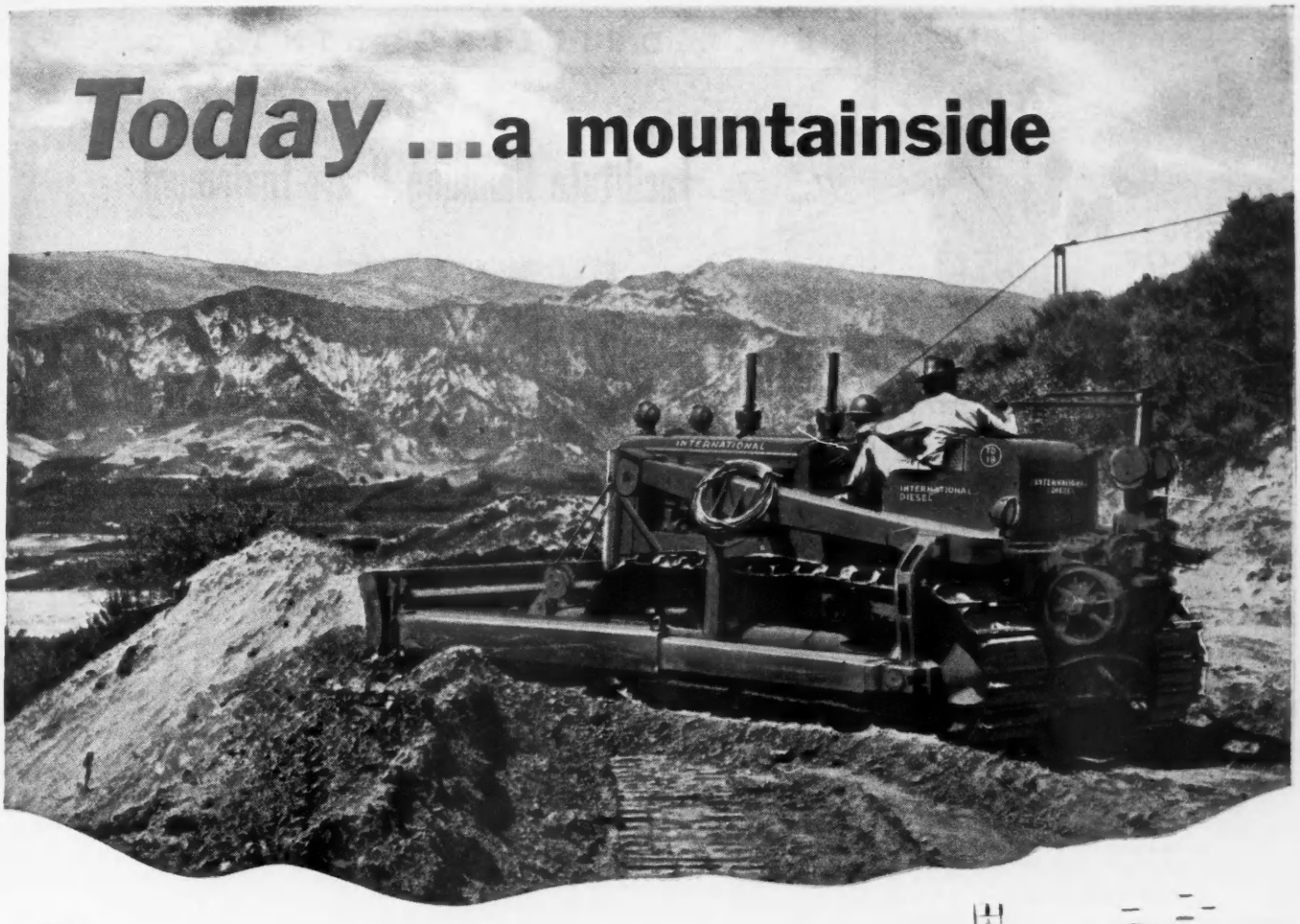

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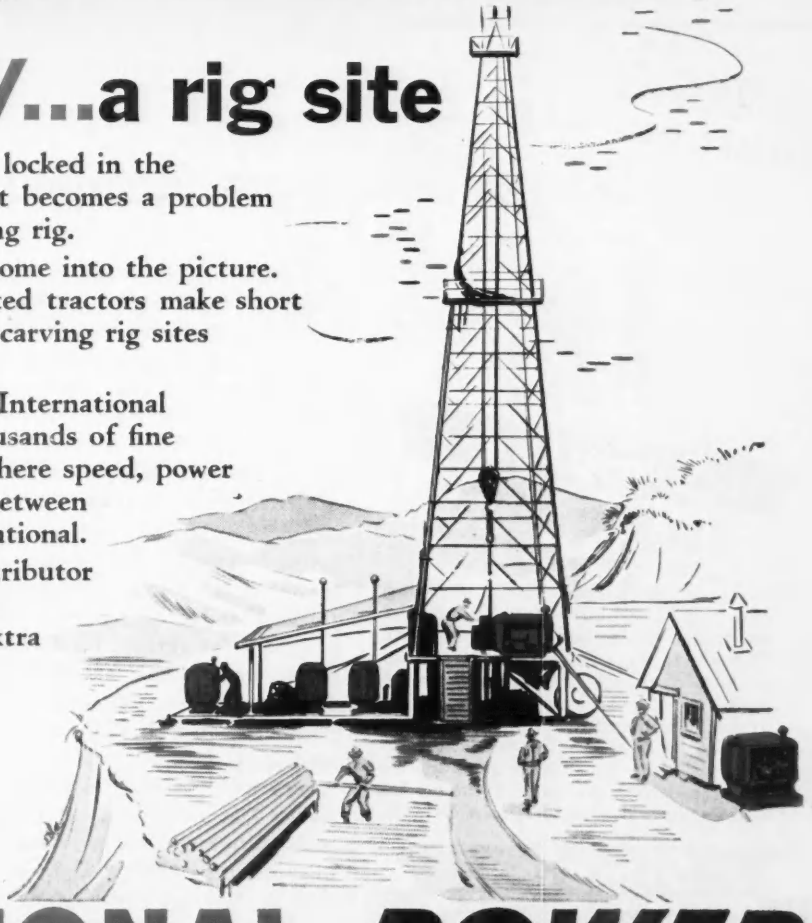

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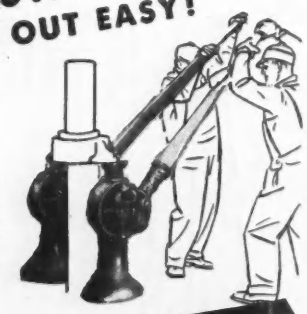

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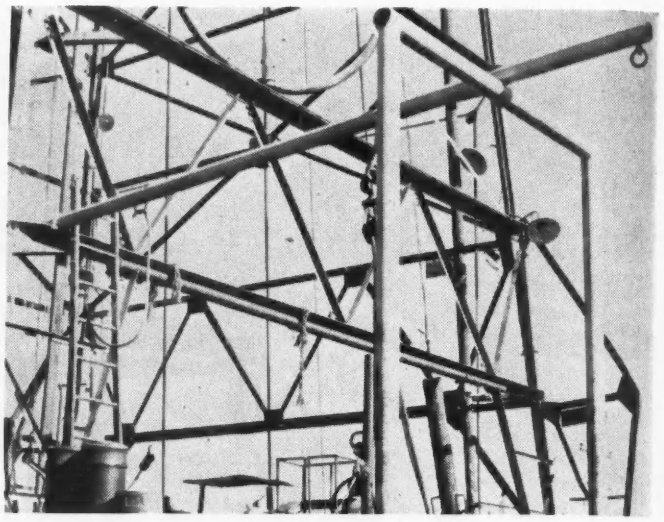
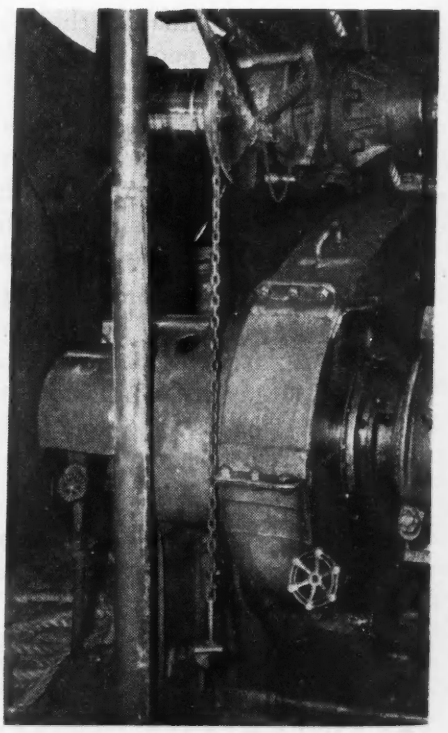
How To—Facilitate Handling Heavy Equipment



Unloading and dragging heavy drilling equipment on the derrick floor can be facilitated by employing a horizontal boom which is solidly anchored. One end of a salvaged piece of drill pipe is bolted to the lower girt, while the outer end is supported and bolted to an inverted "U"-shaped pipe frame also made of drill pipe.

Steel rings are attached to the horizontal boom at either end and near the center. Snatch blocks hooked into either of the rings provide directional pull from three different positions to move heavy material on the floor. The boom is particularly helpful when the catline and cathead are used as the pulling force in making such moves. The boom is also useful to load and unload heavy equipment from trucks. In this case chain hoists or "come-alongs" may be used.

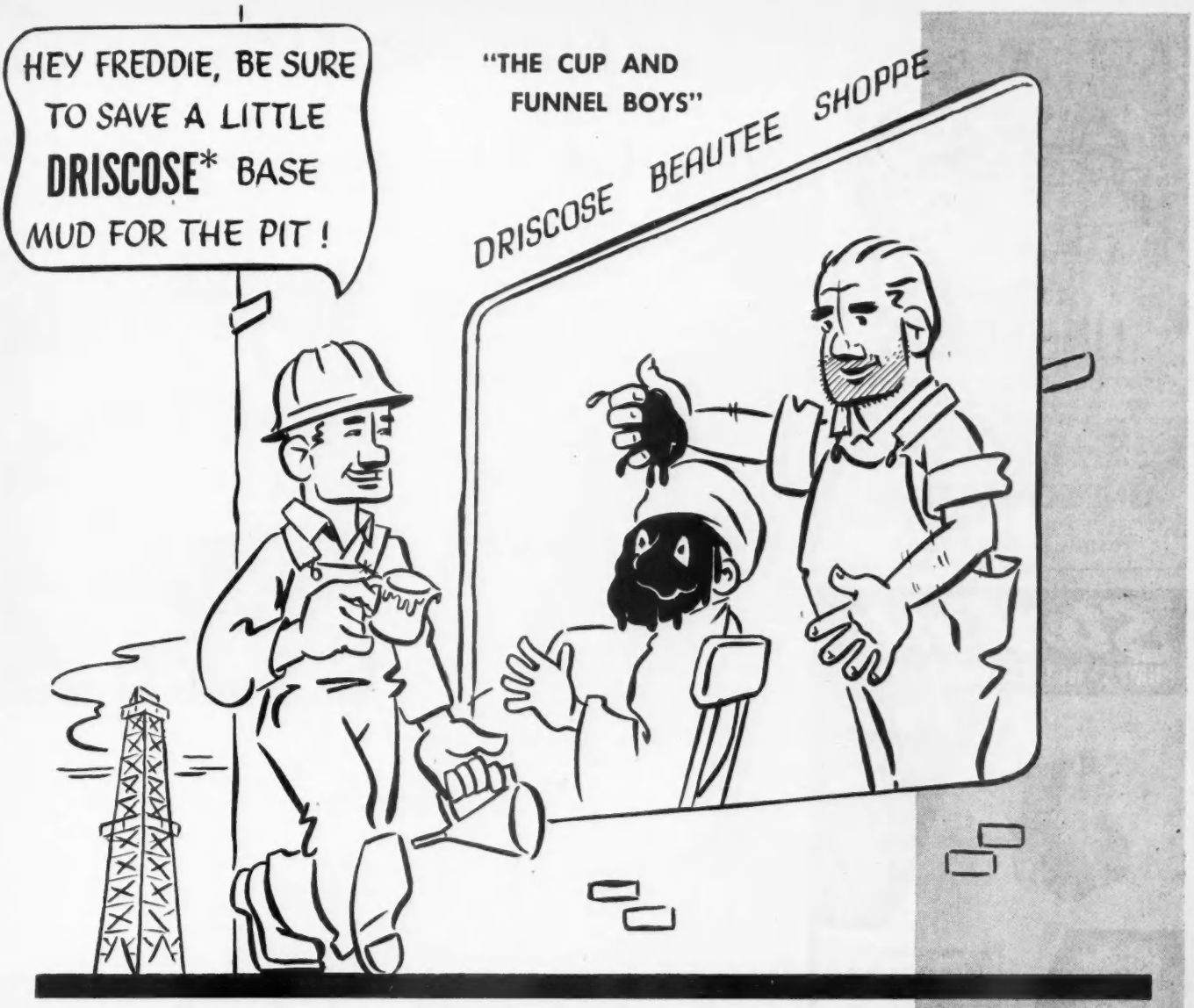
How To—Add Foot Pedal to Cathead Clutch



Addition of a foot treadle and a short length of chain enabled a driller to make a hand-controlled cathead suitable for dual control. With the new hookup the cathead could be operated by foot while both hands were free for engine throttle and/or the brake, or the hand lever could be used without need for the driller to leave his post.

The pedal is hinged to the drawworks housing, and is simply a piece of ½x2-inch strap iron, heated and twisted through 90 degrees midway of its length to give a flat surface for the hinge bolt in one plane and a like surface for the driller's foot in another.

A piece of spinning chain, salvaged after it is worn past usefulness on pipe, serves to hook the pedal to the hand lever. The return spring on the hand lever is tightened or shortened slightly, to support the added weight of the pedal and prevent accidental engagement of the cathead operating clutch. Cost of chain and treadle is negligible and the added convenience will save time on round trips.



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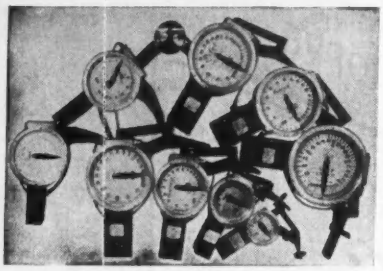

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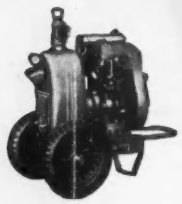

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How To—Cradle Acid Bottle in Bailer

In a field where cable tool drilling to several thousand feet still is quite common, one major operator has developed a somewhat improved method of running the acid bottle. Instead of securing the holder to the bottom of a sinker bar or other tool, it is mounted, instead, in the upper end of the bailer.

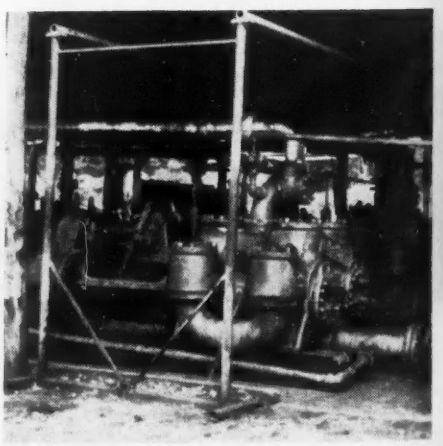
The holder, a short length of pipe fitted with a screw top, is aligned with the axis of the bailer and welded in place in the manner illustrated. When the bottle is run, the bailer is filled with water and lowered to within a few feet of the bottom of the hole, where it is allowed to hang for the time required to etch the glass. Mounted in the top of the bailer, the device is less apt to become broken, and the weighted bailer will lay back against the side of the hole with little tendency to move sideways. The fact that the diameter of the bailer is close to that of the hole will cause the tool to obtain a true picture of the well deviation. The long bailer also will span numerous small, irregular cavities that have been washed out of the side of the hole, thus removing cause of localized errors.

How To—Rig Overhead Crane for Pump Repair

Dismantling either the fluid or power end of a large mud pump requires heavy lifts in removing the pistons, liners, etc. To ease this heavy lifting work, an overhead trolley carrying a chain hoist can easily be constructed.

Illustrated is an installation of this type on two large mud pumps located side by side. This particular location was a wildcat and several months were required for the well, therefore, a foundation was poured for the pumps and a temporary shed was constructed over them.

The chain hoist trolley is made from three-inch pipe and is of sufficient strength to handle the weight of any single part of the pump requiring removal. It is merely a double "U" bracket that has been cross-braced and provided with footings. It is so designed that four men can move it from its position over the pumps if it becomes necessary. When dismantled, the trolley support is broken down into four parts: the two top parallel tracks, and two end supporting members which are welded together with cross pieces as shown. Because of its simplicity and availability, it has been of considerable help in removing pistons and heavy liners.



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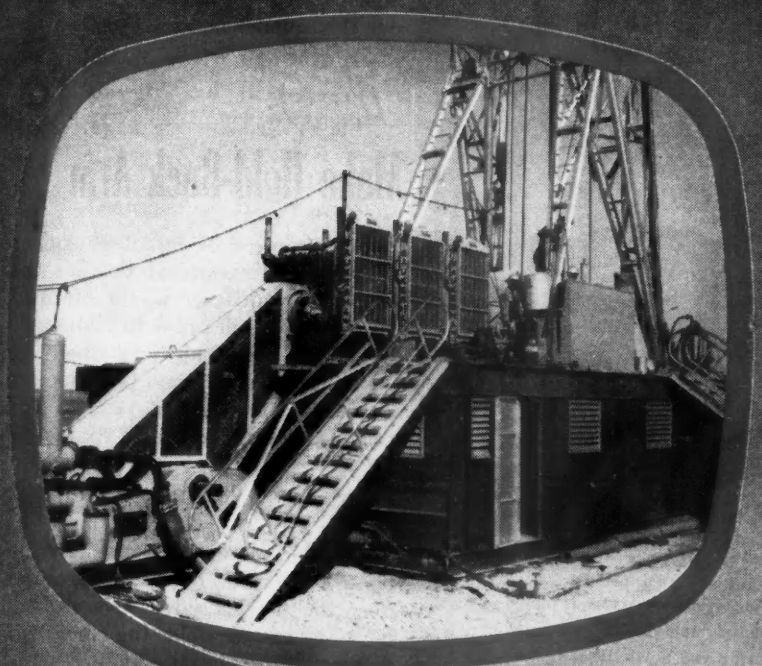

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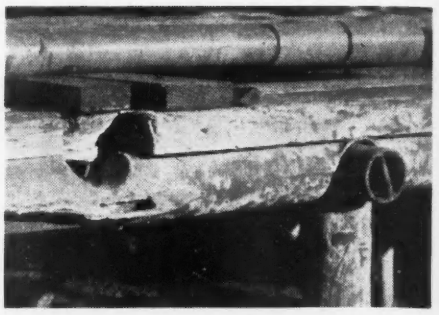
How To—

Improve Loading Rack

Positioning of skids when drill pipe is being loaded or unloaded at the well frequently causes considerable wasted time due to the difficulty of preventing their sliding off to one side, or in having to bar each length of pipe up over slightly elevated points where skids overlap the pipe rack.

One company eliminates much of this difficulty by preparing their rack in the manner illustrated with telescoping sections and notches in the rack. At intervals along the side of the rack a semicircular notch was cut out and a disc, conforming to the shape of the opened area, was welded in. During unloading operations, the ends of the skids are placed in these sockets. Using skids of



4- or 5-inch diameter, the upper surfaces will be very nearly level with the surface of the rack planking.

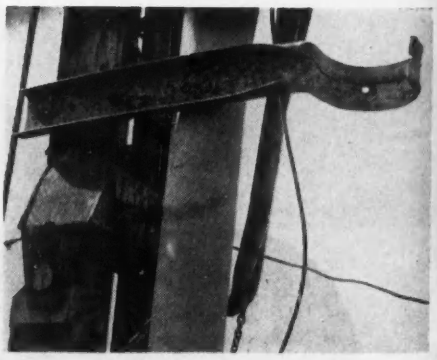
The size smaller pipe fits into an opening cut to the proper size so that this section of pipe can be extended or retracted into the pipe rack as the need arises. It is useful to extend the width of the pipe rack or to be used in spanning the opening between the rack and bed of a truck unloading pipe at the rack. A small cross piece is welded inside this smaller pipe to provide a handle.

How To—

Make Hold-Back Arm

On a cable tool rig, it is convenient to provide a means of holding the bit or bailer, whichever is out of the hole, off to one side in order to eliminate possibility of fouling up lines when drilling or bailing is underway. One operator in a Montana field employs a rigid arm constructed of a length of six-inch channel iron.

Mounted horizontally, the arm is attached with the aid of a large U-bolt to the side of the mast as shown in the photograph. The hold-back projects out over the derrick floor several feet and is designed to hold the tool without danger of the latter slipping out. The outer end of the channel iron was mashed flat and shaped similar to that of a hook. Unscrewing of two nuts from the U-bolt hanger is all that is required to remove the device.



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San Juan Basin

Production, Exploration, Literature

By ROBERT L. BATES

Assistant Professor of Geology, The Newark Colleges, New Jersey

THE San Juan Basin of Northwestern New Mexico and Southwestern Colorado is the most recent of the large structural basins in the Rocky Mountains to be intensively examined and studied by the oil industry. Increasingly during the past three or four years, representatives of major and minor oil companies have been seeking publications, production statistics, data on wildcat wells, and other kinds of information on the region; and such material has been widely scattered. It has therefore seemed apppropriate to summarize here the existing data.

Intensity of current exploratory activity is indicated by the following. During the three-year period ending in mid-1947, oil companies had nine gravity-meter parties in the basin, and a geophysical company had a reconnaissance party there. Eleven magnetometer parties have been active, including one using the new airborne magnetometer. Nine seismograph crews have been in operation during this period, of which five were still at work at this writing. Two more were expected shortly. At least one torsion-balance survey has been made. In addition to this geophysical work, seven parties have done detailed surface geology and several others have made reconnaissance geological surveys. There has been heavy leasing of Indian, federal, and state lands. Offices have been established by five major companies in Albuquerque, and by three in Durango. Field offices are maintained by several companies at Farmington, N. M.

The compilation of a report of this type was suggested by Henry A. Ley, Fort Worth. Although many of the data have been taken from the files of the New Mexico Bureau of Mines and Mineral Resources, for additional information the writer is indebted to A. E. Brainerd, Continental Oil Company, Denver; John A. Frost, U. S. Geological Survey, Artesia, N. M.; H. H. Hinson, U. S. Bureau of Mines, Amarillo; Frank Schultz, Southern Union Production Company, Dallas; Paul H. Umbach, Stanolind Oil & Gas Company, Albuquerque; and W. A. Waldschmidt, Argo Oil Corporation, Midland, Texas.

Much statistical material is presented in tabular form. A considerable effort toward accuracy has been made; but it must be remembered that much of the drilling was done many years ago, often without accurate well-location surveys, elevations, or sample saving. Some examples of notably conflicting data have been indicated by footnotes to the tables. A selected bibliography, arranged by subject, is in part annotated. Sources of maps, aerial photos, well samples, and logs are not included, as they have been listed by Howell and Levorsen (citation in Part 2 of bibliography). The oil and gas fields and pipe lines are shown on Figure 1.

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TABLE 1

Oil Production by Fields to End of 1946[a]

FIELD	Year Discovered	Producing Formation	PRODUCTION IN BARRELS											
			To End of 1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	To End of 1946
ARCHULETA COUNTY, COLO.														
Gramp's	1935	Dakota	.....	217,537	183,751	279,652	325,181	323,987	273,730	251,918	268,446	242,540	231,901	2,598,643
SAN JUAN COUNTY, N. M.														
Rattlesnake	1924	Dakota	3,527,599	279,845	252,354	218,380	137,048	101,791	76,729	58,084	53,079	51,315	38,449	4,794,673
Table Mesa	1925	Dakota	423,957	29,973	26,832	25,264	33,845	36,101	34,516	29,860	22,146	17,137	45,271	724,902
Hogback	1922	Dakota	1,741,429	69,875	73,231	71,254	74,503	72,553	63,713	44,532	65,886	80,677	87,277	2,444,930
Aztec-Bloomfield	1924	Farmington	26,279	3,860x	3,600	3,593	2,286	959	681	445	0	480	1,303x	43,486
Blanco	1927	Farmington, Mesaverde	1,119	70	60	37	46x	21	28	39	0	0	0	1,420
McKINLEY COUNTY, N. M.														
Red Mountain	1934	Mesaverde	1,600x	1,200x	900x	200x	750x	750x	860x	750x	y	1,800	2,650x	11,460
Hospah	1927	Hospah	9,000	2,500x	1,000	19,565	163,781	194,133	297,082	298,360	320,231	292,729	272,882	1,871,263
Totals	.....	.....	5,730,983	604,860	541,728	617,945	737,440	730,295	747,339	683,988	729,788	686,678	679,733	12,490,777

[a] Figures followed by x are estimates. Letter y denotes figures unobtainable. Data from annual petroleum volumes of the A.I.M.M.E. through 1944: from U. S. Geological Survey for 1945 and 1946.

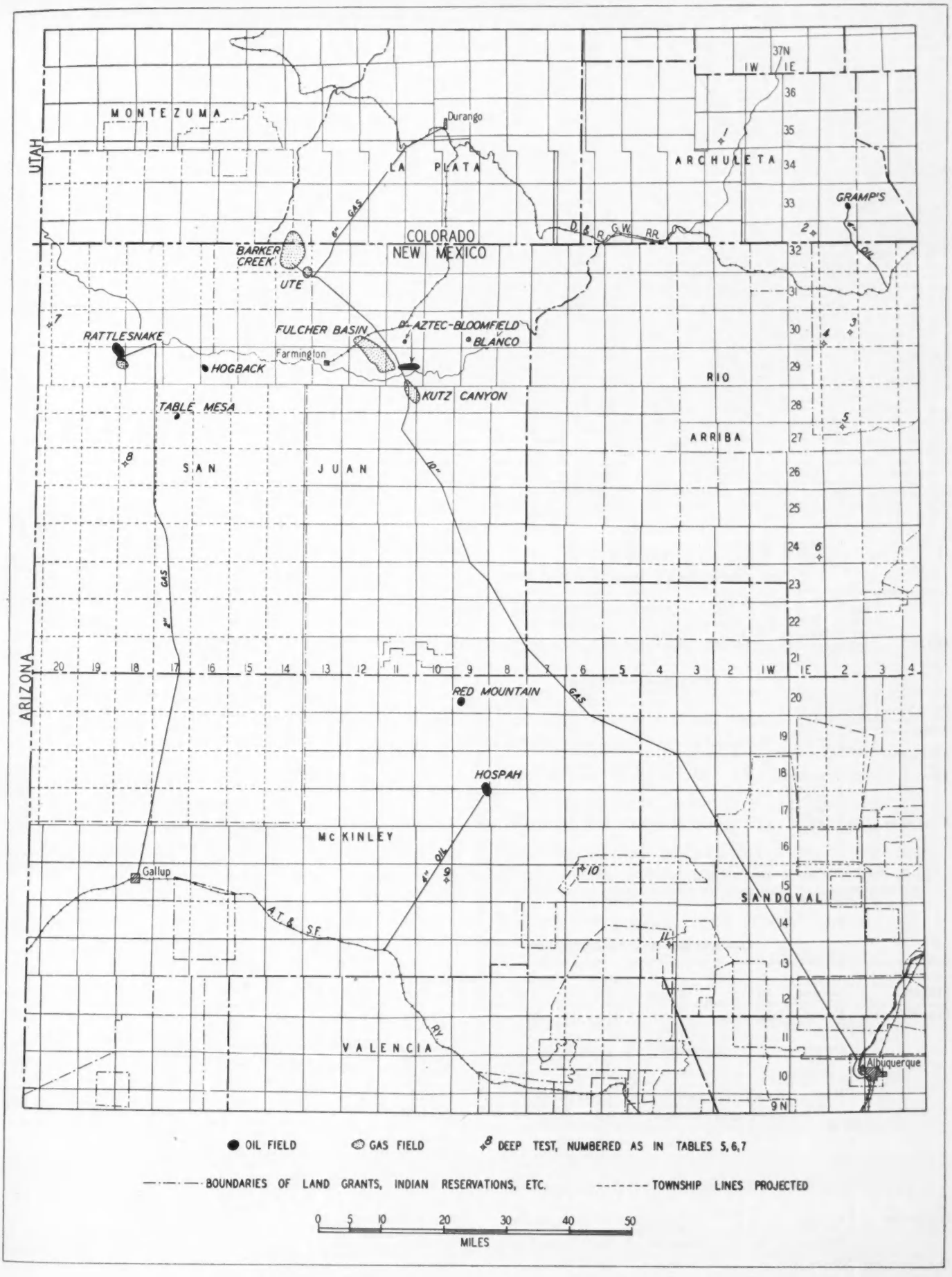

FIGURE 1. Oil and gas fields and pipe lines of the San Juan basin.

ing new oil possibilities. In the discussion relating to the San Juan basin, emphasis is placed on the potentialities of the Paleozoic limestones, especially where they wedge out around the margins of the basin. The paper contains a generalized correlation chart and a list of selected references.

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TABLE 2

Gas Production by Fields to End of 1946[a]

FIELD	Year Discovered	Producing Formation	PRODUCTION IN MILLIONS OF CUBIC FEET											
			To End of 1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	To End of 1946
SAN JUAN COUNTY, N. M.														
Barker Creek	1942	Dakota	.....	.....	.....	.....	.....	.....	932	845	1,422	1,785	1,668	6,652
Ute	1921	Dakota	3,248	668	753	676	887	910	723	925	864	590	527	10,771
Fulcher Basin	1934	Pictured Cliffs	0	0	0	0	48	418	748	1,575	1,597	1,075	1,348	6,809
Aztec-Bloomfield	1924	Farmington	0	0	0	0	65	y	82	50	10	103	0	310
Blanco	1927	Farmington Pictured Cliffs Mesaverde	131	35	29	32	34	44	35	35	0	55	69	499
Kutz Canyon	1927	Pictured Cliffs	5,474	1,164	1,415	1,869	1,952	1,983	1,370	1,404	1,448	1,625	1,661	21,365
Totals			8,853	1,867	2,197	2,577	2,986	3,355	3,890	4,834	5,341	5,233	5,273	46,406

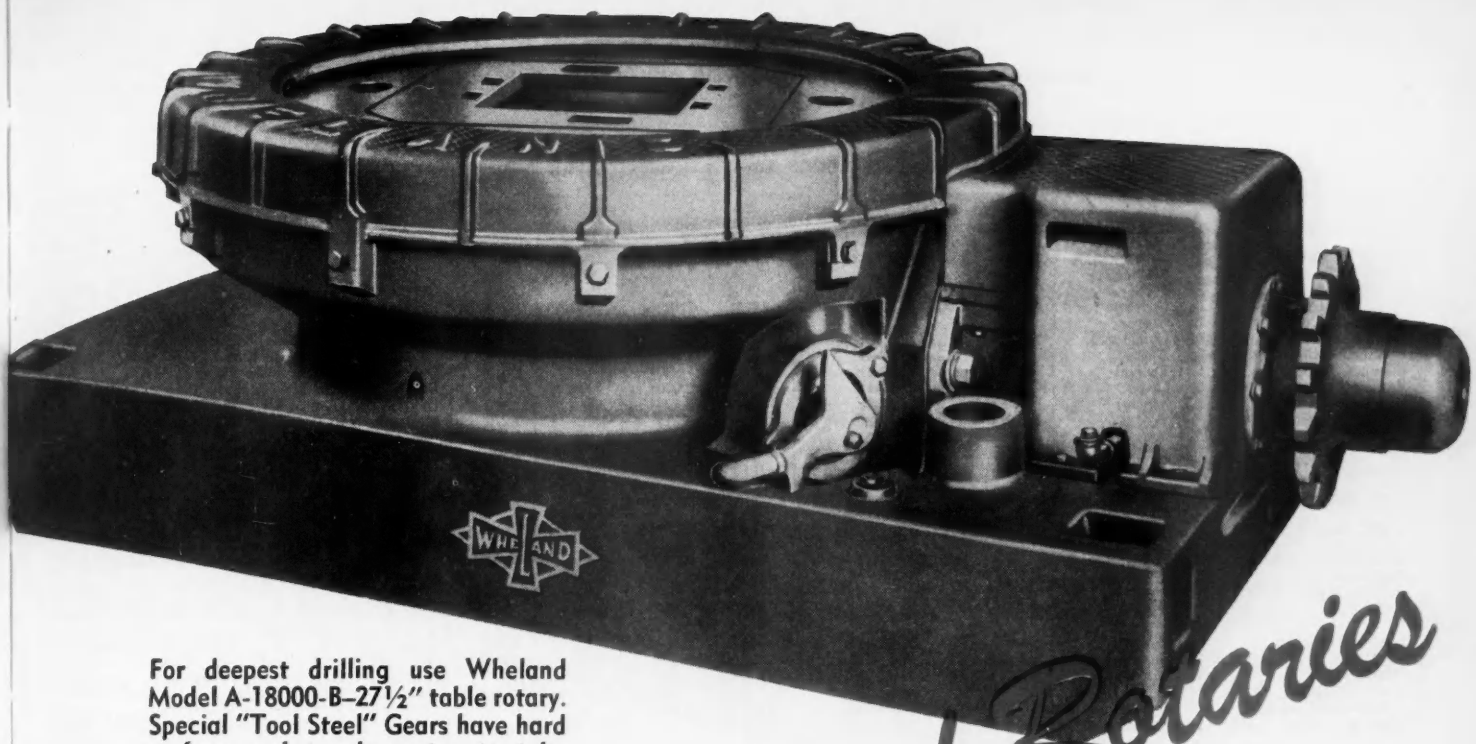
[a] Letter y denotes figure unobtainable. Data from annual petroleum volumes of the A.I.M.M.E. through 1944; from U. S. Geological Survey for 1945 and 1946.

TABLE 3

Oil- and Gas-Bearing Formations

SYSTEM	Formation	Member	Lithology	Oil or Gas	Field	Limits of Pay Zones	Remarks
Upper Cretaceous	Kirtland	Farmington	Sandstone	Oil, gas Gas	Aztec-Bloomfield Blanco	719-1,455 1,650-1,892	57° gravity
	Pictured Cliffs		Sandstone	Gas Gas Gas	Blanco Fulcher Basin Kutz Canyon	2,220-2,245 1,641-2,185 1,596-2,063	
	Mesa-verde	Hospah Allison Point Lookout	Sandstone Sandstone Sandstone	Oil Oil Gas	Hospah Red Mountain Blanco	1,500-1,700 430- 500 4,152-4,157	30° gravity 43° gravity
	Dakota		Sandstone	Oil Oil Oil Oil Gas Gas	Gramp's Hogback Rattlesnake Table Mesa Barker Creek Ute	1,050-1,400 650- 800 700- 900 1,300-1,500 2,165-3,345 2,190-2,428	32° gravity 60° gravity 76° gravity 56° gravity
Pennsylvanian	Hermosa		Limestone	Oil	Rattlesnake*	6,585-6,720	40° Gravity
	Paradox		Limestone	Gas	Barker Creek	8,396-8,875	Sour gas
Mississippian and Devonian	Leadville-Ouray		Limestone	Gas	Rattlesnake	7,000-7,200	7.6% Helium

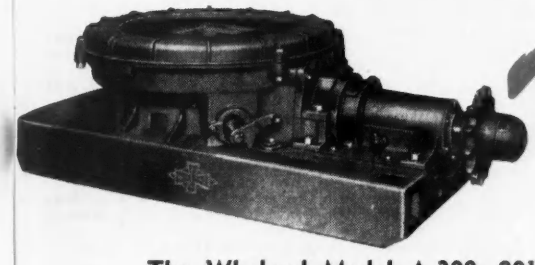
* Commercially produced, 1929-1940.



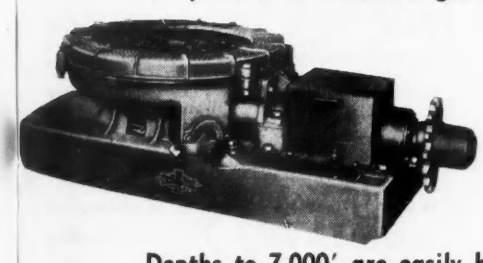
For deepest drilling use Wheland Model A-18000-B–27½" table rotary. Special "Tool Steel" Gears have hard surface and tough center to take heavy loads and extreme shock.

Wheland Rotaries

PUT the BITE on the BIT—



The Wheland Model A-300, 20½" Rotary is built for high speeds to 10,000' depths. Available with straight or spiral bevel hardened gears.



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Wheland products are one of the many superior lines of oil field equipment available thru your nearby Jones & Laughlin Supply Store. You'll find these stores conveniently located in every section of the oil country between the Rockies and the Atlantic.

JONES & LAUGHLIN SUPPLY COMPANY

Subsidiary of Jones & Laughlin Steel Corporation

J&L STEEL

TULSA, OKLAHOMA

TABLE 4

Wildcats and Representative Field Wells Drilled to the Dakota Sandstone

Arranged by State, County, Township, Range, and Section.

COMPANY	Well No.	Lease	¼—¼—¼	Sec., Tp. N, Rge.	Date Comp.	Elevation	Top Dakota	Total Depth	Formation at T.D.	REMARKS
COLORADO—Archuleta County										
K. L. Kendrick	1	Crowley	.....	2-32-1E	1908	7,400[4]	200±	1,208	Morrison?	D. & A.
Florance, Teague et al	1	Fitzhugh	C-NE-NE	4-32-1E	.....	7,500[4]	810	860	Dakota	P. B.; testing. Water in Dakota
Oriental Refining Co	1	Ewell	C-SE-NE	4-32-1E	4-29-47	7,400[4]	892	960	Dakota	D. & A. HFW 945-60
Navajo Oil Co	1	Crowley	NE-SW-SW	11-32-1E	1925	7,400[4]	300	390	Dakota	D. & A.
Axelind Oil Co	1	Crowley	.....	2-32-2E	1936	7,800[4]	?	2,465	?	D. & A.
Axelind Oil Co	1	Chindstrom	NE-NW	12-32-2E	1939	8,400[4]	2,200	2,470	Morrison	D. & A. Hot sulfur water in Dakota
Continental Oil Co. et al	1	Burns	.....	21-32-4E	1937	8,800[4]	?	1,305	?	D. & A. Reached Dakota?
Florance, Bigbee	1	Federal	SW-NW	17-33-1E	6-25-47	7,800[4]	2,490?	2,511	Dakota	D. & A. Sulfur water in Dakota
Barney Cockburn	1	Caulk	C-SW-SE	27-33-1E	.....	7,600[4]	930	.....	Dakota	SDO at 953; HFW in Dakota
Byrd-Frost et al	1	Taylor	NE-SW-NE	14-33-2E	1946	8,500[4]	2,720	2,890	Dakota	D. & A. Water and slight SO & G in Dakota
[1]L. M. Hughes	16	Fee	NE-NW-SE	24-33-2E	1939	8,116	1,063	1,273	Morrison	In Gramp's field. Produced 122,206 bbls. oil, 1939-1945
Ben Owen et al	1	Haystack	SW-NE-NW	17-34-2W	?	8,000[4]	1,300±	1,300	Dakota	D. & A. Water in Dakota
Pagosa Oil & Dev. Co.	1	Macht	SE-NW	32-36-1W	1940	7,500[4]	1,840?	2,460[5]	Morrison?	D. & A. SO at 1,840 in Dakota? Dakota also repted. at 2,115
La Plata County										
Ohio Oil Co	1	Snyder	C-NE[6]	11-33-12W	1927	6,793	3,400	3,845	Morrison	On Red Mesa. D. & A. Dakota dry
Cohis Oil Co	1	Hall	NW-NW	13-33-12W	1924	6,700[4]	3,460	3,600	Dakota	D. & A. SO in Dakota
Erdman Prod. & Drlg. Co	1	Pulliam	SW-SW-NW	22-33-12W	1927	6,600[4]	3,464	3,525	Dakota	D. & A. SG and 42° oil, drowned by salt water at T. D.
McGarr Pet. Corp	1	Sanchey	SE-SE-NE	27-33-12W	1931	6,500[4]	3,155	3,320	Dakota	D. & A. SG and 35° oil in Dakota
Joe Dinger	1	Sanchez	NE-NE	27-33-12W	6-20-46	6,405	3,170	3,362	Morrison	D. & A. HFW in Dakota
[2]McGarr Pet. Corp	1	Pinyon Mesa	NE-NE	34-33-12W	7- 4-36	6,580	3,476	3,678	Morrison	D. & A. SO in Dakota
J. A. Leidecker	?	?	.....	2-34-10W[7]	1925	7,500[4]	?	1,700	Dakota?	D. & A. Dakota dry
J. F. Collins Corp	1	Aspares	SW-SW-NW	10-34-11W	1928	7,400[4]	2,847	3,012	Dakota	D. & A. Water in Dakota
Klem Pet. Corp	1	Olbert	SW-SW	8-35-12W	.....	7,327	1,350	.....	.....	On Thompson Park structure. Drilling intermittently
NEW MEXICO—McKinley County										
Producers & Refiners Corp	1	?	.....	25-13-9W	?	6,782	632	1,856	Chinle?	D. & A. SO and sulfur water in Dakota
Midwest Refining Co	1	San Mateo	NE-NE-SE	14-14-8W[8]	1-27-24	7,478	1,075	1,320	Morrison	On San Mateo dome. D. & A. water in Dakota
S. Dysart	1	?	SW-SW-SW	21-14-9W	8- -29	7,000[4]	?	1,800±	Triassic?	D. & A. Ref.—U.S.G.S. Bull. 860-B, p. 79
New Mexico Royalties Co	2	Barton	NE-NE-NE	30-14-9W	1926	6,950[4]	855	925	Dakota	P. B. for water well acc. to U. S. G. S. Bull. 860-B, p. 79
[3]Ambrosia Investment Corp	1	Fee	SW-SE	11-14-10W	1-12-41	6,850	700	1,720	Chinle	On South Ambrosia Lake Dome. P. & A. Water in Dakota
Marland Oil Co	1	Santa Fe	SE-NE-NW	5-14-19W	5-15-26	7,168	822	1,405	Morrison	On Defiance anticline. D. & A. no shows
Midwest Refining Co	1	Chavez	NE-NE-NE	4-15-6W	9-19-23	6,825?	1,914	2,154	Morrison	On Chavez anticline. D. & A. Water in Dakota
Midwest Refining Co	1	Walker	SW-SW-NW	13-15-10W[9]	12-26-23	7,375	1,125	1,460	Morrison	On Walker dome. D. & A.
Gallup Dome, Inc	1	Santa Fe	SW-SE-SE	22-15-18W	.....	6,700[4]	1,200±	.....	.....	SDO at 2,250 in Wingate
[3]Gallup American Coal Co	1	Lockhart	NW-SW-SW	25-15-18W	7- 3-23	6,923	1,185	2,265	Chinle?	On Gallup dome. Commercial water in Dakota
Carter Oil Co	1	Santa Fe	NW-SW	29-15-19W	4-10-19	6,600[4]	765	1,155	Navajo?	On Defiance anticline. D. & A. Water in Dakota
Hogback Oil Co	1	Horten	SE-SE-NW	12-16-10W	11-23-27	7,000[4]	2,290	2,350	Dakota	On Vogt anticline. D. & A. Water and SO in Dakota
Ohio Oil Co	1	Nightingale	NW-NW	25-17-6W	11- 1-27	6,280	1,790	1,807	Dakota	On Chico anticline. Comp. in Dakota as water well
Continental Oil Co	1	Carica	SW-SW	9-17-7W	2-13-28	6,643	3,075	3,190	Morrison	On Carica anticline. D. & A. Water in Dakota
Midwest Refining Co	1	Hancock	SE-NW	1-17-9W	8-24-27	6,633	2,990	3,282	Morrison	In Hospah field. P. B. as producer from Hospah sand. Water and SO in Dakota
Arkansas Fuel Oil Co	1	Santa Fe	NE-NW	19-17-9W	4- 2-28	6,795	2,740±	2,925	Morrison	4 mi. southwest of Hospah field. D. & A. Water in Dakota
San Juan Coal & Oil Co	1	Santa Fe	NW-SW-SW	17-18-9W	12-13-33	6,900[4]	3,158	3,255	Dakota	4 mi. northwest of Hospah field. P. & A. Water in Dakota
Petroleum Products Ref. & Prod. Co	53	State	SE-SE-SE	36-18-9W	2-20-47	6,702	3,057	3,105	Dakota	In Hospah field. P. B. as producer from Hospah sand. Dakota dry
E. T. Hamilton	1	Ruby	C-SW-SW	33-19-10W	1921	6,816?	3,085	3,265	Dakota	2 mi. northeast of Seven Lakes anticline D. & A. Water in Dakota
Rio Arriba County										
Continental Oil Co. et al	1	Esquibel	.....	27-28-4E[10]	10- 1-38	7,759	1,790	1,920	Dakota	P. & A. Sulfur water in Dakota
H. L. Williams	1	Martinez	SE-SE-NE	3-30-2E[10]	1926	7,900[4]	?	1,200	?	D. & A. Reached Dakota?
Owens Albuquerque Oil Co	1	Fee	C-SW-SE	1-31-1E[10,11]	5-29-26	7,680	7,659	1,008	Morrison	On Azotea dome. D. & A. Water in Dakota
Paul S. Ache et al	1	Martinez	SW-NW-SW	17-31-1E	10- 3-26	7,326	1,417	1,427	Dakota	On Monero dome. D. & A. Hot Water in Dakota
Jarvis Bennett et al	1	Fee	C-NE-SW	8-31-1W	7- -30	7,400[4]	2,470	2,577	Dakota	On Dulce dome. D. & A. Water in Dakota
Paul S. Ache et al	1	Garcia	SE-NW-NW	13-31-1W	11- 3-25	7,550[4]	1,393	1,520	Dakota?	On Monero dome. D. & A. Water in Dakota
Continental Oil Co. et al	1	Jicarilla	S½-SE-NE	22-31-1W	7-13-40	8,100?	2,340	2,373	Dakota	One Dulce dome. P. B. for water well. Water in Dakota
Prairie Oil & Gas Co	1	?	NE	2-31-2E[10]	1925	8,900[4]	?	1,800	?	D. & A. SO in Dakota
Azotea Oil Co	1	Fee	NE-NE	17-31-2E[10]	6- -28	7,700[4]	1,060±	2,300	?	D. & A.
Louis R. Travis	1	Wirt	NW-SE-SE	21-31-2E[10]	12-17-44	7,865	425	705	Morrison	P. & A.
R. S. Rhodes	1	Sargent	SW-SE-NE	23-31-3E[10]	11-28-44	7,709	35	880	Wingate	P. & A.
Axelind Oil Co	1	Gonzales	SE-SE-NE	13-32-1E[10]	8-25-38	8,050	934	1,022	Dakota	On Chromo anticline. P. & A. Sulfur water and SG in Dakota
Barnes et al	1	?	C-W½	13-32-1E[10]	11-12-24	7,900[4]	725?	725	Dakota	D. & A.
Prairie Oil & Gas Co	1	Gonzales	SE-SE-NE	20-32-2E[10]	?	7,690	658	758	Morrison	D. & A.
Prairie Oil & Gas Co	1	Gonzales	NW-SW-NW	32-32-2E[10]	Before 1923	8,238	1,405	1,508	Dakota	On Chromo anticline. A. & D. Water in Dakota
Sandoval County										
[2]F. B. Umbarger	1	Armijo	SE-NW-NW	1-12-3W	12-29-45	5,900[4]	719	1,000	Morrison	On Rio Puerco anticline. P. & A.
Harry Leonard et al	1	Catron	C-NW-NE	7-18-1W	1926	6,434	1,790	2,003	Morrison	On La Ventana anticline. D. & A. Water in Dakota

■ TABLE CONTINUED ON PAGE 124

DRILLING CONTRACTORS:

Here's the Shaffer Pressure Control Hook-Up that meets your every requirement for maximum safety, simplicity and wide-range adaptability. Check its many advantages . . . its all-around protection and versatility. You'll find it unsurpassed for modern drilling operations.

For continuous and automatic pressure control while drilling —

THE SHAFFER COMBINATION ROTATING BLOW-OUT PREVENTER AND STRIPPER

No matter how sudden the pressure emergency, it can't happen too fast for this pressure control unit *because it is always packed off around the drill string as long as pipe is in the hole!*

No levers or valves to operate. No time delay. It maintains its pressure-tight seal *continuously,* even around varying diameters and shapes. These are a few of its many unique features . . .

ANY SHAPE! The Stripper Rubber automatically expands and contracts to maintain a tight seal around any diameter in the drill string (except for such abnormally large diameters as reamer and bit). It seals off around the kelly, whether square, hexagonal or octagonal . . . and around the varying diameters of drill pipe, couplings, tool joints and drill collar. Adjustment to different diameters and shapes is completely automatic — no manual operations are necessary.

CONTINUOUS SEAL! Not only does the Stripper Rubber seal off around any shape or diameter in the drill string, but its automatic and instant adjustment to varying shapes and sizes permits the drill string to be stripped in and out of the unit without losing seal at any time. Pipe is run into the hole and removed with the same convenience and simplicity as in conventional drilling operations.

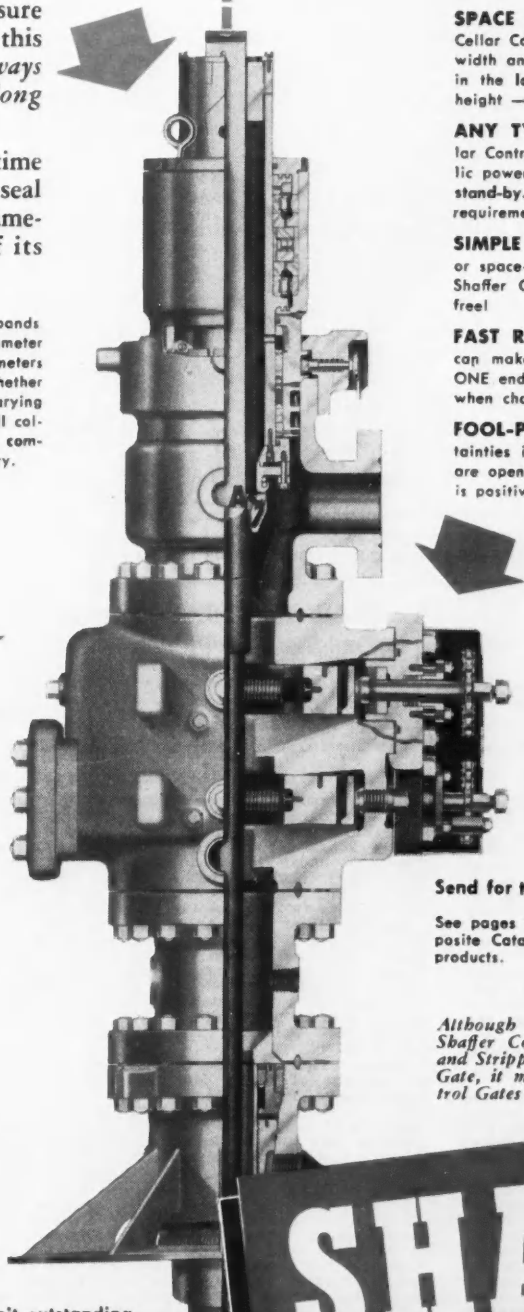
MINIMUM WEAR! Since the Stripper Rubber rotates with the kelly — not around it — there is practically no wear on the rubber. Maintenance is negligible.

QUICK RELEASE! When running such large tools as the bit or reamer through the unit, simply pull a spring latch, rotate the bonnet 1/6th turn and the complete rotating assembly is readily withdrawn from the body on top of the bit or reamer. When going back into the hole simply reverse the operation. It's quick and simple!

UNUSUALLY COMPACT! The Shaffer Combination Rotating Blow-Out Preventer and Stripper is so engineered that vertical height in the drilling riser is kept at a minimum. In addition, flow connections built directly into the body eliminate need for spools or other accessories for overflow connections, thus saving still more space.

STEEL PROTECTED RUBBER! Note how the Stripper Rubber is backed by flexible steel latches (A) which form an expandable steel barrier to prevent extrusion when the rubber is subjected to unusually high pressure or to abnormal expansion. This flexible steel barrier so protects the rubber that large diameters can be pulled through it without damage . . . and even extremely high well pressures will not cause the rubber to extrude.

There are many other features that make this unit outstanding for highest efficiency and safety in modern drilling operations. Write for the complete details.



For complete shut-off whether drill string is in or out of well . . .

THE SHAFFER DOUBLE CELLAR CONTROL GATE

This unit not only provides complete shut-off of open hole, but also seals around the drill string to provide added protection and safety when blow-outs threaten while pipe is in the hole. Note its compactness and fool-proof dependability — how it can be easily adapted to varying power requirements — and other outstanding advantages . . .

SPACE SAVING COMPACTNESS! All Shaffer Cellar Control Gates are unusually compact in length, width and height. And the Shaffer Double Gate, even in the largest size, requires less than 29" of cellar height — smaller sizes even less!

ANY TYPE POWER! You can operate Shaffer Cellar Control Gates with air, steam, electric or hydraulic power drives — plus the added safety of manual stand-by. There's a choice of power to meet every well requirement!

SIMPLE INSTALLATION! No complicated piping or space-wasting pressure manifolding is required for Shaffer Gates. Installation is simple, clean, clutter-free!

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Shaffer, pioneer of modern pressure control equipment, also offers a complete range of control equipment in addition to the units shown above . . . Shaffer Kelly Cocks, Shaffer Adjustable Flow Beans, Shaffer Landing Heads, Tubing Heads, and other control equipment . . . plus a complete line of field-proven fishing tools.

Send for the complete Shaffer Catalog!

See pages 3454 to 3506 of your 1947 Composite Catalog for more details on Shaffer products.

Although the above Shaffer Hook-Up shows the Shaffer Combination Rotating Blow-Out Preventer and Stripper with the Shaffer Double Cellar Control Gate, it may also be used with Shaffer Single Control Gates in any arrangement, if desired.

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■ CONTINUED FROM PAGE 122

San Juan County

Petroleum Products Ref. & Prod. Co.	1	Santa Fe	SE-SE-NW	21-21-8W	5-25-47	6,466	4,325	4,707	Morrison	On Cayedito dome. P. & A. SSO & G in Dakota
Navajo Co.	1	Raymond	Near S¼ cor.	4-25-19W	1925	5,850[4]	275	3,290	Chinle	On Beautiful Mountain anticline. Comp. as water well. Fresh water in Dakota
Continental Oil Co.	1	Tocito	SW-SE-NW	8-26-18W	6-20-26	5,800[4]	880	1,430	Navajo	On Tocito dome. Comp. as water well. Fresh water in Dakota
Gypsy Oil Co.	1	Tocito	NW-NE-SW	17-26-18W	5-31-24	5,800[4]	842	3,022	Chinle	On Tocito dome. Fresh water in Dakota
Byrd-Frost et al.	1	Hargrave	C-NE-NW	4-27-10W	.....	6,149	6,525	6,745	Morrison	Testing: SO & G in Dakota
[1]Continental Oil Co.	3	Table Mesa	SE-NE-SW	3-27-17W	1-15-26	5,340	1,328	1,336	Dakota	In Table Mesa field. I. P. 225 BOPD, 58° gravity, from Dakota
Continental Oil Co.	1	Navajo	SE-SE-SE	14-28-19W	8- -45	5,520[12]	1,340	1,510	Morrison	5 mi. south of Rattlesnake field. P. & A. Water in Dakota
[1]Midwest Refining Co.	9	Hogback	SE-NW-NE	19-29-16W	10- 8-24	5,004	625	647	Dakota	In Hogback field. I. P. 212 BODP, 60° gravity, from Dakota. In July, 1933, 79 BOPD
Red Cactus Oil Co.	1	Navajo	SE-SE-SE	35-29-18W	5-26-41	5,260[12]	1,500	1,680	Dakota	Between Rattlesnake and Table Mesa fields. P. B. for water well from Tocito sand. Water in all 3 Dakota sands.
[1]Continental Oil Co.	51	Rattlesnake	C-NW-NE	2-29-19W	12-30-38	5,243	690	752	Dakota	In Rattlesnake field. Pump 14 BOPD from 690-708 ft.
Continental Oil Co.	2	Navajo	NW-NW-SE	36-29-19W	10- -45	5,400[12]	1,320	1,482	Dakota	3 mi. south of Rattlesnake field. Comp. as water well. Water in Dakota
Childers Drlg. & Prod. Co.	2	Westwater	NW-SE-NW	24-31-16W	7-28-29	5,850[4]	2,395	2,490	Dakota	Between Chimney Rock and Barker Creek domes. D. & A. SO & G and fresh water Dakota
Continental Oil Co.	1	Chimney Rock	SW-SE	34-31-17W	1-29-27	5,230	1,425?	2,002	Morrison?	On Chimney Rock dome. D. & A. Sulfur water in Dakota
Four States Oil Syndicate	1	Sickler	SW-SW-NW	31-32-13W	11-24-25	6,740	2,935	2,943	Dakota	1½ mi. east of Ute field. D. & A. SO in Dakota
[1]Southern Union Prod. Co.	4	Barker	C-NE	16-32-14W	9- 1-43	7,508	3,224	3,345	Morrison	In Barker Creek field P. B. to 3,285. I. P. 2,960 MCFGPD from 3,224-33 and 3,243-85 after 100-qt. shot.
[1]Midwest Refining Co.	2	Ute	SW-SW	36-32-14W	6-30-22	6,514	2,205	2,428	Dakota	In Ute field. I. P. 36,212 MCFGPD from 2,370-79 and 2,415-28

Valencia County

Dudley Cornell.	1	State	NW-SW-NE	36-11-8W	2-12-45	7,500[4]	1,050	1,167	Morrison	On anticline 6 mi. south of Mt. Taylor. P. & A. Dakota dry

[1] Representative field well. [2] Representative of a closely spaced group of dry holes. [3] Representative of a closely spaced group of commercial water wells. [4] Estimated from state topographic map. [5] 2,640 according to local residents. [6] Or NE-SE? Or NW-SE? [7] Location approximate; "4 miles southwest of Durango." [8] In sec. 15 according to U.S.G.S. Bull. 860-B, p. 79. [9] In sec. 14 according to U.S.G.S. Bull. 860-B, p. 79. [10] On Tierra Amarilla grant; section lines projected from adjacent surveyed areas. [11] Well with same name, T. D., and completion date also listed as in SE-SE-NE sec. 8-31N-2E. [12] Estimated from quadrangle map.

TABLE 5
Deep Wildcats in Northeastern San Juan Basin

Index No.*	Company	Well No.	Lease	¼-¼-¼	Sec., Tp. N, Rge.	Date Comp.	Elevation	Total Depth	Formation At Surface	FORMATION TOPS: Dakota	Morrison	Todilto	Wingate	Chinle	Pennsylvanian	Pre-Cambrian	Remarks
COLORADO—Archuleta County																	
1	Wirt Franklin et al	1	Sullenberger	NE-SW-SW	28-35-2W	....	7,700§	1,668	Mancos	30	290	1,060	1,170	.....	.....	1,323	D. & A.
2	Phillips Pet. Co.	1	Crowley	SW-SW-SW	12-32-1E	1943	7,672	1,624	Mancos	240	500	1,235	1,325	.....	.....	1,620	D. & A.
NEW MEXICO—Rio Arriba County																	
3	E. T. Williams	1	Willow Creek	SE cor.?	23-30-2E†	1920	8,200§	2,054	Mancos	225	303	?	?	?	?	1,923	D. & A.
4	The California Co.	2	Looney		31-30-2E†	12-21-20	7,900§	1,783	Mancos	200	390	?	?	?	?	1,690?	D. & A.
5	Phillips Pet. Co.	1	El Vado	NE-SW?	3-27-2E†	8-20-43	6,800§	2,009	Dakota	.....	380	965	1,048	1,230	1,530	1,815	P. & A.
6	Continental Oil Co.	1	French Mesa	SE-SE-SW	25-24-1E	4- 5-26	8,420‡	3,355	Triassic	.....	.....	.....	.....	.....	2,605	.....	D. & A.

* See map, Fig. 1. § Estimated from state topographic map. † On Tierra Amarilla grant; section lines projected from adjacent surveyed areas. ‡ Estimated from quadrangle map.

and Chupadera formations in the Zuni and Nacimient uplifts, and of the Supai and Coconino formations on the Defiance uplift.

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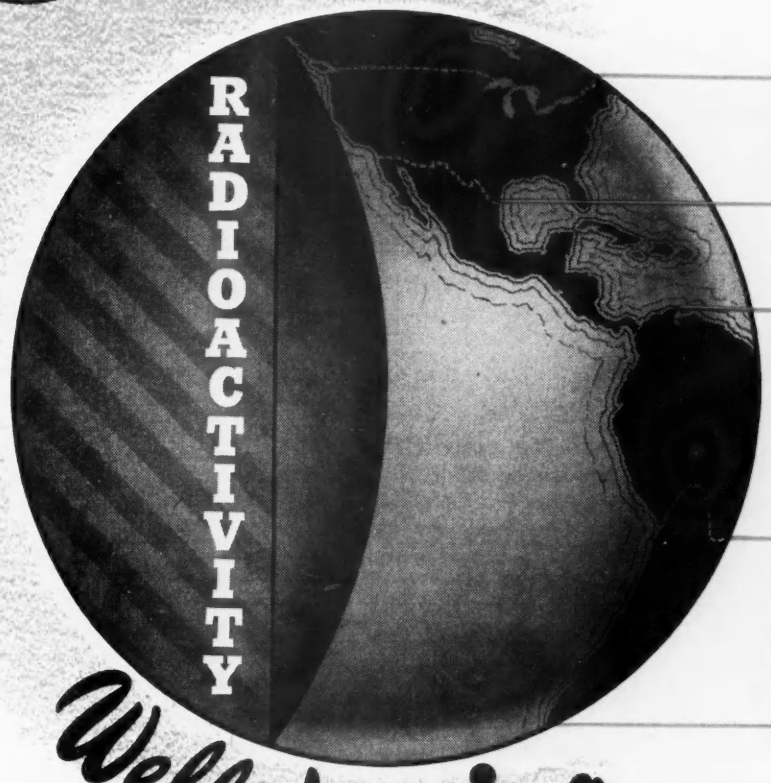

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TABLE 6

Deep Wildcats in Northwestern San Juan Basin

Index No.*	WELL DATA	Formation at Surface	FORMATION TOPS										
			Dakota	Morrison	Wingate	Chinle	Shinarump	Cutler	Hermosa	Molas	Ouray	Elbert	Ignacio
	San Juan County, New Mexico												
7	Continental Oil Co. 1 Biltabito. NE-SW-NE sec. 13-30N-21W, Biltabito dome. Comp. Aug. 1943, El. 5,493. T.D. 4,840. P. & A.	Wingate	.....	.....	.....	140±	1,330	1,500	3,040	4,320	4,480	4,730	4,820
8	Continental Oil Co. 1 Tocito. C-NW-SW sec. 17-26N-18W, Tocito dome. Comp. 5-19-43. El. 5,852. T.D. 6,919; P.B. to 6,700. 2,600 MCFGPD from Ouray ls. at 6,659-6,700 after acid. Salt water at 6,700. P. & A.	Mancos	850	1,050	1,830	2,720	3,850	4,200	5,730	6,410	6,600	6,755	6,910

* See map, Fig. 1.

TABLE 7

Deep Wildcats in Southern San Juan Basin

Index No.*	WELL DATA	Formation at Surface	FORMATION TOPS									
			Dakota	Morrison	Todilto	Wingate	Chinle	San Andres	Yeso	Abo	Pennsylvanian	Pre-Cambrian
	McKinley and Sandoval Counties, New Mexico											
9	Plymouth Oil Co. 1-A Santa Fe. SW-SW-NW sec. 13-15N-10W, Walker dome. Comp. 10-7-45. El. 7,260. T.D. 6,210. P. & A.	Mancos	1,240	1,330	2,280	2,300	2,510	3,930	4,020	5,050	5,620	6,015
10	Richfield Oil Corp. 1 Drought. NW-NW-SE sec. 4-15N-6W, Chavez anticline. Comp. 8-4-46. El. 6,654. T.D. 7,145. P. & A.	Mancos	1,930	2,050	2,900	2,970	3,070	4,550	4,670	5,740	6,312	7,140
11	Continental Oil Co. 1 Evans, SE-SE-NE sec. 2-13N-4W. Comp. 12-3-35. El. 6,570. T.D. 6,220. P. & A.	Mancos	258	290	1,130	1,250	1,330	2,765	2,865	3,630	4,815	6,134

* See map, Fig. 1.

TABLE 8

Deep Gas Wells of the Southern Union Production Company in the Barker Creek Field

Well No.	Location in T32N, R14W	Date Comp.	Elevation	Total Depth	I.P., MCF GPD	Pay Zones	Formation At Surface	FORMATION TOPS													
								Pt. Lookout	Mancos	Dakota	Morrison	Pony Express	Wingate	Chinle	Shinarump	Cutler	Hermosa	Paradox	Molas	Leadville	Ouray	Elbert	Ignacio
9	SE-SE-NW Sec. 21	4- 3-45	6,237	9,466	42,000	8,420-98, 8,620-50	Point Lookout	.....	434	2,280	2,500	3,490	3,570	4,020	4,820	5,050	6,630	7,910	8,860	9,060	9,200	9,310	9,420±
11	C-SE-NW Sec. 16	9-21-45	6,415	9,002	27,000	8,855-75	Menefee	400	530	2,512	2,760	3,720	3,820	4,278	5,070	5,279	6,840	8,155	8,973	.....	.....	.....	.....
13	C-NW-NE Sec. 29	3- 2-46	6,134	8,830	46,000	8,396-8,460	Point Lookout	.....	340	2,278	2,522	3,500	3,580	4,050	?4,950	?5,180	6,790	7,890	8,820	.....	.....	.....	.....
17	C-NW-NW Sec. 27	11-26-46	6,097	9,387	30,000	8,510-50	Menefee	?	?	2,390	2,640	3,610	3,680	4,200	5,040	5,200	6,825	8,150	9,040	9,210	?9,315	.....	.....
18	NW-SW-SW Sec. 11	4-15-47	6,761	9,265	74,000	8,925-9,005	Menefee	?	968	2,840	3,030	4,020	4,120	4,560	?5,280	5,460	7,125	8,330	.....	.....	.....	.....	.....

TABLE 9

Deep Wells in the Rattlesnake Field

WELL DATA	FORMATION TOPS										
	Dakota	Morrison	Wingate	Chinle	Shinarump	Cutler	Hermosa	Molas	Ouray	Elbert	Ignacio
Continental Oil Co. 17 Rattlesnake. SW-SE-NE sec. 2-29N-19W. Comp. 6-7-29 El 5,294. T. D. 6,771. I.P. 800 BOPD, 40° gravity, and much water, from Hermosa ls. below 6,497. Deepened to 6,985. P. & A., 1943	710	840±	?	?	3,875	4,145	5,710	6,880	.....	.....	.....
Continental Oil Co. 24 Rattlesnake. SW-NW-SW sec. 1-29N-19W. Comp. June 1932. El. 5,310. T. D. 7,370. I.P. 500 BFPD, 95% oil, from Hermosa ls at 6,585-6,620. P. & A. 1943	725	960±	1,860	2,720	3,870	4,170	5,750	6,900	7,070	7,295	.....
Continental Oil Co. 100 Rattlesnake. SE-NW-NE sec. 2-29N-19W. Comp. 1-23-40. El 5,275. T.D. 7,407. Show oil, 41° gravity, and much water, from Hermosa ls. at 6,724-32. P. & A., 1943	718	900±	1,940	2,800	3,950	4,210	5,696	6,860	7,045	7,260	7,405
U. S. Bureau of Mines 1 Navajo. NE-NE-SW sec. 13-29N-19W. Comp. 5-17-43. El. 5,294. T.D. 7,036; P.B. to 7,004. I.P. 33,000 MCFGPD, approx. 7% helium, from Ouray ls. at 6,958-82 after 1,000 gals acid. Wellhead pressure 2,990 lbs. Shut in	780	950	1,930	2,740	3,930	4,150	5,720	6,770	6,955±	.....	.....
U. S. Bureau of Mines 1-G Rattlesnake. C-SE-SE sec. 13-29N-19W. Comp. 8-26-43. El 5,350. T.D. 7,049. I.P. 17,300 MCFGPD, approx. 7% helium, from Ouray ls. below 6,971. Wellhead pressure 2,980 lbs. Shut in	820	980	1,960	2,850	3,970	4,190	5,775	6,835	6,970	.....	.....

Calculation of the Effect of *Pressure Maintenance* On Oil Recovery

By ROBERT L. HOSS
Petroleum Engineer

CALCULATIONS to determine the effect of pressure maintenance by gas injection on the ultimate recovery of oil from a solution gas-drive reservoir are reviewed by the author. Data derived in this manner permit comparative economic analyses to be made and the most profitable withdrawal program determined. This article is based on the author's paper which appeared in the September, 1947, issue of *Petroleum Technology*, published by the AIME.

THE purpose of this paper is to consider the method of calculating the effect of pressure maintenance by gas injection on the ultimate recovery of oil from a solution gas-drive reservoir. These calculations of reservoir behavior are based on equations presented by M. Muskat.[1]

It is possible to express mathematically the change in reservoir oil saturation with pressure decline in a solution gas-drive reservoir as being equal to the change in the physical properties of the fluids present in the reservoir as this pressure decline occurs. Essentially, these equations, in differential form as presented by M. Muskat, express quantitatively the instantaneous net effect of the simultaneously occurring changes in the reservoir volume factor, oil and gas viscosity, gas solubility in oil, and gas density, and the accompanying changes in permeability to oil and gas.

The equation for the change in oil saturation as pressure declines during primary depletion is

$$\omega(\rho_o, p)\frac{d\rho_o}{dp} = \rho_o\lambda(p) + (1-\rho_w-\rho_o)\varepsilon(p) + \rho_o\Psi(\rho_o)\eta(p) \quad (1)$$

If gas is injected to arrest pressure decline, the following equation applies:

$$\frac{d\rho_o}{dp} = \frac{\rho_o\lambda(p) + [H(1-\rho_w-\beta\rho_{o1}) + (1-\rho_w-\rho_o)]\,\varepsilon(p) - H\rho_{o1}\frac{d\beta}{dp} + \left(\Psi(\rho_o) - \frac{rR}{\alpha(p)}\right)\rho_o\eta(p)}{1 + \frac{\mu_o}{\mu_g}\left(\Psi(\rho_o) - \frac{rR}{\alpha(p)}\right)} \quad (2)$$

where:

$$\alpha(p) = \gamma\beta\frac{\mu_o}{\mu_g},\quad \omega(\rho_o, p) = 1 + \frac{\mu_o}{\mu_g}\Psi(\rho_o),$$

$$\lambda(p) = \frac{1}{\gamma\beta}\frac{ds}{dp} \quad (3)$$

$$\varepsilon(p) = \frac{1}{\gamma}\frac{d\gamma}{dp},\quad \eta(p) = \frac{\alpha(p)}{\beta^2\gamma}\frac{d\beta}{dp}$$

These equations and their utility can be better understood by a review of the essential steps in their derivation, in the manner set forth in the original Muskat reference.

For solution gas-drive recovery, the surface gas-oil ratio at any given oil saturation is

$$R = S + \alpha(p)\Psi(\rho_o) \quad (4)$$

or the dissolved gas plus the gas which flowed to the well bore in the free state.[1,2]

The volume of oil produced within any time interval or during any very small pressure decrement may be expressed as the difference between the volume of oil in place in the reservoir at the beginning of the pressure decrement and the volume of oil in place at the end of the pressure decrement. The surface equivalent of this change in oil saturation per unit volume of pore space is written as:

$$Q_o = \Delta\left(\frac{\rho_o}{\beta}\right)$$

Wherein:

$$\Delta\frac{\rho_o}{\beta} = \frac{\Delta\rho_o}{\beta} - \frac{\rho_o}{\beta^2}\Delta\beta$$

This last equation expresses the stock tank oil produced during some small pressure decrement as being equivalent to the total reduction in oil saturation less that reduction in oil saturation resulting from shrinkage of the remaining oil.

Likewise, the standard volume of free gas produced during any small pressure decrement is equal to the change in the standard volume of dissolved gas present in the reservoir plus the change in the standard volume of free gas present in the reservoir as gas saturation, minus the standard volume of gas which occupies the pore space voided by the reservoir oil produced during this small delta pressure or pressure decrement. This is expressed as:

$$Q_g = \frac{\rho_o}{\beta}\Delta S + (1-\rho_w-\rho_o)\Delta\gamma - \gamma\Delta\rho_o$$

Hence the surface gas-oil ratio can also be expressed as:

$$R = S + \frac{Q_g}{Q_o}$$

or:

$$R = S + \frac{\frac{\rho_o}{\beta}\Delta S + (1-\rho_w-\rho_o)\Delta\gamma - \gamma\Delta\rho_o}{\frac{\Delta\rho_o}{\beta} - \frac{\rho_o}{\beta^2}\Delta\beta} \quad (5)$$

Equating equation (4) to equation (5), and expressing the delta quantities as differentials by considering the pressure decrement to be infinitely small, results in:

$$\gamma\beta\,\frac{\mu_o}{\mu_g}\,\Psi(\rho_o) = \frac{\frac{\rho_o}{\beta}\,\frac{dS}{dp} + (1-\rho_w-\rho_o)\,\frac{d\gamma}{dp} - \gamma\,\frac{d\rho_o}{dp}}{\frac{1}{\beta}\,\frac{d\rho_o}{dp} - \frac{\rho_o}{\beta^2}\,\frac{d\beta}{dp}} \quad (6)$$

By rearranging the terms of equation (6):

$$\frac{d\rho_o}{dp} + \left(\frac{d\rho_o}{dp} - \frac{\rho_o}{\beta}\,\frac{d\beta}{dp}\right)\left(\frac{k_g}{k_o}\,\frac{\mu_o}{\mu_g}\right) = \rho_o\,\frac{1}{\gamma\beta}\,\frac{dS}{dp} + (1-\rho_w-\rho_o)\,\frac{1}{\gamma}\,\frac{d\gamma}{dp} \quad (7)$$

In this equation the term:

$$\frac{d\rho_o}{dp} - \frac{\rho_o}{\beta}\,\frac{d\beta}{dp}$$

is the change in reservoir oil saturation minus the shrinkage of the remaining oil, or is the actual instantaneous volume of reservoir oil which moved into the well bore.

Equation (7) states (from left to right) that the change in reservoir oil saturation plus the reservoir volume of free gas which flows to the well bores during this reduction in saturation is equal to the reservoir volume occupied by the gas which is released from the remaining oil plus the reservoir volume of the expansion of free gas already present. Hence this expression can be considered an instantaneous material balance of the withdrawal process during primary depletion by solution gas-drive.

By transposing terms and using the abbreviations of equations (3), equation (7) becomes:

$$\omega(\rho_o, p)\,\frac{d\rho_o}{dp} = \rho_o\lambda(p) + (1-\rho_w-\rho_o)\,\varepsilon(p) + \rho_o\Psi(\rho_o)\eta(p) \quad (1)$$

This is the desired end differential equation for primary depletion.

The cumulative stock tank recovery in decimal fraction of pore volume at any residual oil saturation is expressed by the following equation:

$$\text{Cum. Rec.} = \left(\frac{\rho_o}{\beta}\right)_i - \left(\frac{\rho_o}{\beta}\right) \quad (8)$$

Equation (2), the fundamental expression for the case of pressure maintenance, is derived in the same manner as shown for primary recovery, and the following equation is obtained:

$$\frac{d\rho_o}{dp} + \left(\frac{d\rho_o}{dp} - \frac{\rho_o}{\beta}\,\frac{d\beta}{dp}\right)\left(\frac{k_g}{k_o}\,\frac{\mu_o}{\mu_g}\right) - \frac{rR}{\beta\gamma}\left(\frac{d\rho_o}{dp} - \frac{\rho_o}{\beta}\,\frac{d\beta}{dp}\right) = \rho_o\,\frac{1}{\gamma\beta}\,\frac{dS}{dp} + (1-\rho_w-\rho_o)\,\varepsilon(p) + H(1-\rho_w-\beta\rho_{oi})\,\varepsilon(p) - H\rho_{oi}\,\frac{d\beta}{dp} \quad (9)$$

In terms of reservoir volumes, equation (9) states (from left to right) that the change in oil saturation in the reservoir plus the volume of free gas which flows to the well bores minus the volume of gas returned to the formation is equal to the volume occupied by the gas which is released from the oil remaining in the oil zone plus the expansion of free gas already present plus the expansion of free gas in the gas cap minus the shrinkage of the oil in the gas cap. The volume of gas released from the oil in the gas cap has been neglected in the equation, although it is recognized that some pressure support in the oil zone is available from this gas liberation. This expression can be considered an instantaneous material balance of the withdrawal process in the oil zone during solution gas-drive depletion under pressure maintenance by gas injection.

By transposing terms and using the abbreviations of equations (3), equation (9) becomes:

$$\frac{d\rho_o}{dp} = \frac{\rho_o\lambda + [H(1-\rho_w-\beta\rho_{oi}) + (1-\rho_w-\rho_o)]\,\varepsilon - H\rho_{oi}\,\frac{d\beta}{dp} + \left(\Psi - \frac{rR}{\alpha}\right)\rho_o\eta}{1 + \frac{\mu_o}{\mu_g}\left(\Psi - \frac{rR}{\alpha}\right)} \quad (2)$$

In arriving at these expressions the following assumptions are made: The connate water saturation remains constant; any gas cap is non-expanding; and any gas injected is uniformly diffused through all of the producing horizon.

Nomenclature

- o, g, w — subscripts denoting oil, gas, and water, respectively
- p — pressure, psi
- k — permeability in millidarcys
- μ — viscosity in centipoises
- R — total or gross surface gas-oil ratio, cubic feet per cubic foot
- S — solubility of gas in oil, cubic feet per cubic foot (expressed as cubic feet per barrel in Figure 1)
- β — volume factor, reservoir volume occupied by a unit volume of oil at standard surface conditions
- γ — relative gas density, cubic feet per cubic foot, or the volume of gas at standard conditions required to occupy 1 cubic foot of space at reservoir conditions.
- ρ — residual saturation, expressed as the decimal fraction of the pore volume occupied by the fluid
- λ, ε, η — numerical quantities, functions of pressure, with units of 1/p or square inch per pound
- α, ω — numerical quantities, dimensionless functions of pressure
- $\Psi(\rho_o)$ — relative permeability ratio or k_g/k_o
- r — decimal fraction of the produced gas returned to the reservoir
- i — initial conditions
- H — ratio of the thickness of the gas cap to the thickness of the oil zone
- ρ_{oi} — initial residual oil saturation in the gas cap, expressed as the surface volume equivalent.

Method

These differential equations can be integrated numerically by assuming the rate of change of the various properties of the reservoir fluids to remain constant over some short pressure interval such as 100 pounds per square inch, as was used in these calculations. In assuming this pressure decrement, the differential quantities become delta quantities and can be obtained as slope values directly from the curves of these properties versus pressure, as shown in Figure 1 for a crude oil sample. These slope values are required for the pressure rate of change of volume factor, gas solubility, and relative gas density. This assumption of a linear relationship is valid throughout most of the pressure decline with the exception of the 500 psi to 0 psi interval. Hence no significant error is introduced at most pressures. In addition, average values over the assumed pressure decrement in question must be obtained from the curves for gas and liquid viscosities.

To minimize the errors inherent in this stepwise-integration procedure, all values of the physical properties of the fluids varying with pressure, as shown in Figure 1, were taken at the mid-point of each successive pressure interval of 100 psi.

A value of the relative permeability ratio for the oil saturation existing at the beginning of the particular pressure decrement in question is then taken from the curve in Figure 2. This curve is typical of Permian limestones. At present, the most reliable relative permeability data are obtained from the observed well and reservoir performance of the reservoir being studied or of a similar reservoir.

The end result of the calculations over

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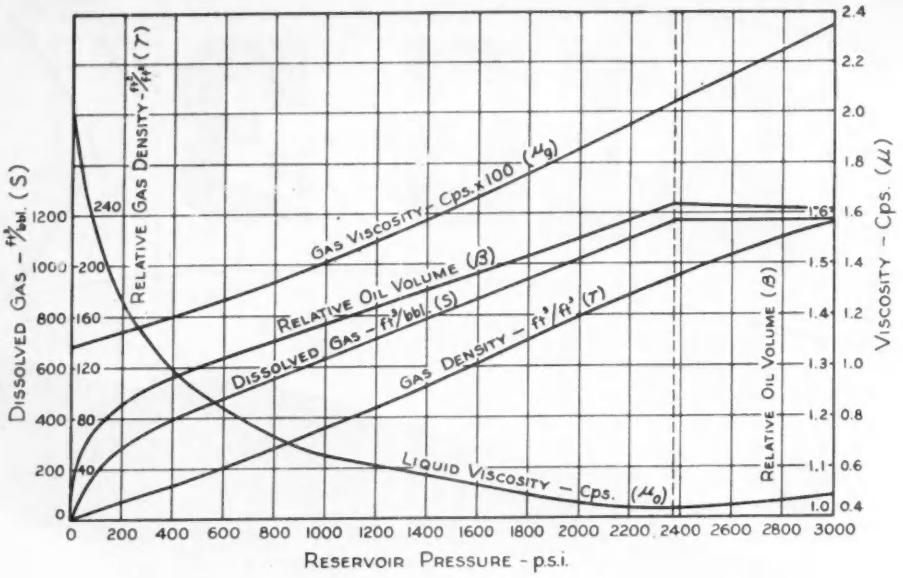

Dissolved Gas – ft³/bbl. (S)
Relative Gas Density – ft³/ft³ (γ)
Gas Viscosity – Cps. x 100 (μg)
Relative Oil Volume (β)
Dissolved Gas – ft³/bbl. (S)
Gas Density – ft³/ft³ (γ)
Liquid Viscosity – Cps. (μo)
Relative Oil Volume (β)
Viscosity – Cps. (μ)
Reservoir Pressure - p.s.i.

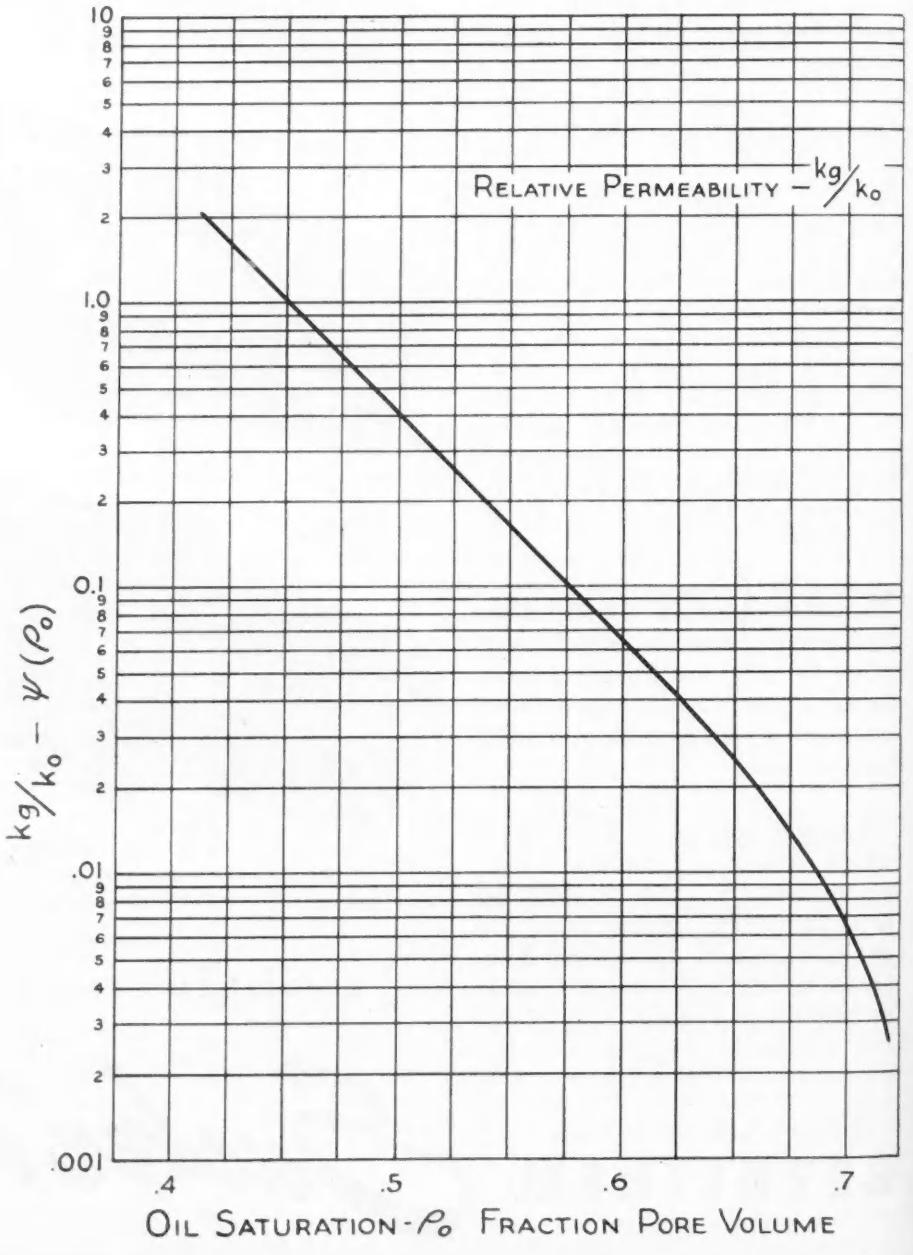
FIGURE 1 (Left)
Reservoir fluid characteristics.

any pressure decrement is a change in the reservoir oil saturation. The subtraction of the change in oil saturation from the previous value of saturation results in a new residual oil saturation which actually exists along with its corresponding $\frac{k_g}{k_o}$ value only at the beginning of the next ensuing pressure decrement. This $\frac{k_g}{k_o}$ value is assumed to hold over the next pressure decrement, for purposes of calculation.

By following the procedure outlined, the equations were evaluated in stepwise fashion for successive 100 psi intervals beginning with the saturation pressure of 2370 psi and continuing down to the abandonment pressure. The abandonment pressure is reached when the reduction in volume factor becomes equivalent to the reduction in residual oil saturation. When this pressure is reached little or no further withdrawal can be expected from solution gas-drive.

The average gas-oil ratio during each pressure interval was determined in the

FIGURE 2 (Below)
Relative permeability.



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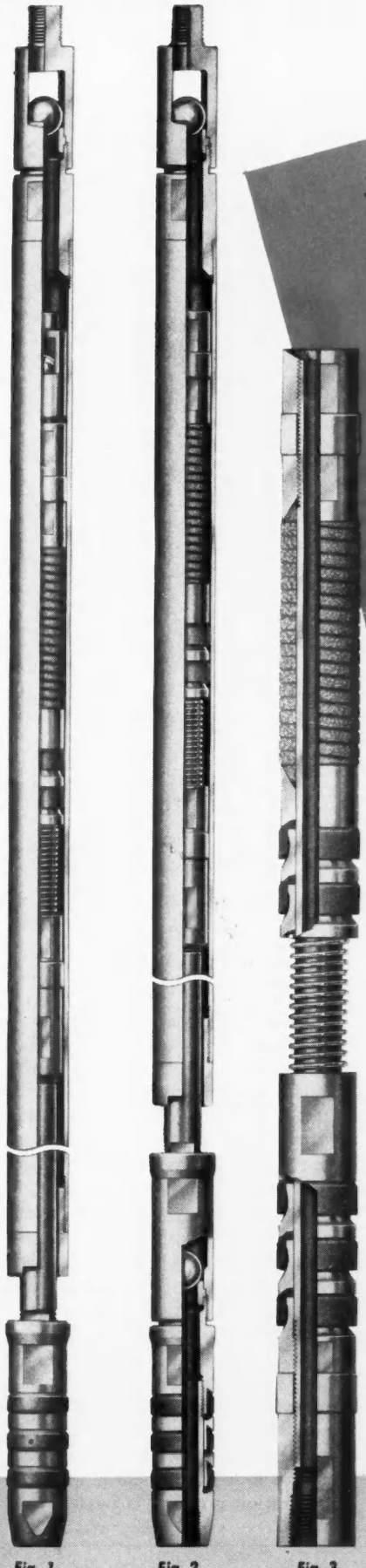

Fig. 1
Traveling Barrel Assembly with 2 Cup and Packing Plunger With Gas Valve.

Fig. 2
Traveling Barrel Assembly with 2 Cup and Packing Plunger Without Gas Valve

Fig. 3
5 Cup and Packing Plunger Without Gas Valve

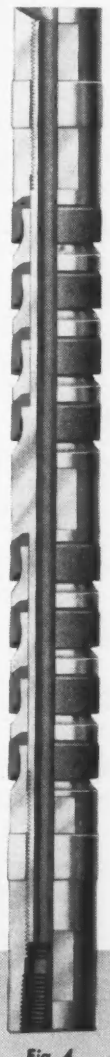

Fig. 4
8 Cup Plunger Without Gas Valve

Fig. 5
4 Cup Plunger Without Gas Valve

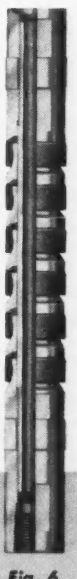

Fig. 6
6 Cup Plunger Without Gas Valve

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conventional manner by using the relative permeability and fluid property data from Figure 1 in equation (4).

Sample Calculations

The following sample calculations illustrate the method of determining the change in reservoir oil saturation during a 100 psi decline in reservoir pressure and the average gas-oil ratio during that decline, for both primary recovery and pressure maintenance where r = 0.6.

1. A pressure decrement is taken at random as being from 1600 psi to 1500 psi.

The following data at 1550 psi are obtained from Figure 1:

$\gamma = 118$ ft³/ft³

$\beta = 1.475$

$\mu_o = 0.54$ cps

$\mu_g = 0.0165$ cps

$S = \frac{850}{5.62} = 151$ ft³/ft³

$\frac{dS}{dp} = 6.92 \times 10^{-3}$

$\frac{dr}{dp} = 10.78 \times 10^{-3}$

$\frac{d\beta}{dp} = 1.7 \times 10^{-4}$

2. The final equation to be solved for the case of *primary recovery* is

$$\frac{d\rho_o}{dp} = \frac{\rho_o\lambda(p) + (1-\rho_w-\rho_o)\,\varepsilon(p) + \rho_o\Psi(\rho_o)\eta(p)}{\omega(\rho_o, p)}$$

(1) The parts of Equation 1 are evaluated separately.

$\rho_o = 0.61$ = the value existing at 1600 psi and assumed to hold over the next 100 psi pressure drop, until the next ensuing $\Delta\rho_o$ can be evaluated for the subsequent pressure decrement, or 1600 to 1500 in this case.

$$\lambda(p) = \frac{1}{\gamma\beta}\frac{dS}{dp}$$

$$= \frac{1}{118 \times 1.475} \times 6.92 \times 10^{-3}$$

$$= 3.98 \times 10^{-4}$$

$(1-\rho_w-\rho_o) = \rho_g = 0.76 - \rho_o = 0.15$

$$\varepsilon(p) = \frac{1}{\gamma}\frac{d\gamma}{dp}$$

$$= \frac{10.78 \times 10^{-3}}{118} = 9.13 \times 10^{-4}$$

$\Psi(\rho_o) = k_g/k_o$ @ $\rho_o = 0.61$, from Fig. 2 = 0.0525

$$\alpha(p) = \gamma\beta\frac{\mu_o}{\mu_g}$$

$$= 118 \times 1.475 \times \frac{0.54}{0.0165} = 5690$$

$$\eta(p) = \frac{\alpha(p)}{\beta^2\gamma}\frac{d\beta}{d\gamma}$$

$$= \frac{(5690) \times (1.7 \times 10^{-4})}{(1.475)^2 \times 118}$$

$$= 37.7 \times 10^{-4}$$

$$\omega(\rho_o, p) = 1 + \frac{\mu_o}{\mu_g}\Psi(\rho_o)$$

$$\omega(\rho_o, p) = 1 + \frac{0.54 \times 0.0525}{0.0165} = 2.72$$

(2) Substituting the values from (1) in the final equation:

$$\frac{d\rho_o}{dp} = \frac{(0.61)\,(3.98 \times 10^{-4}) + (0.15)\,(9.13 \times 10^{-4}) + (0.61)\,(0.0525)\,(37.7 \times 10^{-4})}{2.72}$$

$$= 1.84 \times 10^{-4}$$

$\Delta\rho_o = (1.84 \times 10^{-4})\,(100) = 0.0184$

$\therefore$ the new ρ_o @ 1500 psi = 0.61 − 0.0184 = 0.592

(3) Gas-oil ratio calculation:

$R = S + \alpha(p)\Psi(\rho_o)$

$R = 151 + 5690 \times 0.0525$

$R = 151 + 299 = 450$

$R = 450 \times 5.62 = 2530$ ft³/bbl.

(4) Cumulative recovery @ reservoir pressure of 1600 psi.

$$\text{cum. rec.} = \left(\frac{\rho_o}{\beta}\right)_i - \left(\frac{\rho_o}{\beta}\right)$$

$$\text{cum. rec.} = \frac{0.76}{1.60} - \frac{0.61}{1.485} = 0.059$$

3. The final equation to be solved for the case of *pressure maintenance* is:

$$\frac{d\rho_o}{dp} = \frac{\rho_o\lambda(p) + [H(1-\rho_w-\beta\rho_{oi}) + (1-\rho_w-\rho_o)]\,\varepsilon(p) - H\,\rho_{oi}\frac{d\beta}{dp} + \left(\Psi(\rho_o - \frac{rR}{\alpha(p)}\right)\rho_o\eta(p)}{1 + \frac{\mu_o}{\mu_g}\left(\Psi(\rho_o) - \frac{rR}{\alpha(p)}\right)}$$

(1) The data shown in steps 1 and 2, (1) are used to evaluate the parts of this equation, since the pressure taken is again 1550 psi. The terms including H drop out since no gas cap exists.

(2) $R = S + \alpha(p)\Psi(\rho_o)$

$R = 151 + 5690 \times 0.168$

$R = 1106$

$R = 1106 \times 5.62 = 6210$ ft³/bbl.

where $\Psi(\rho_o) = k_g/k_o$ @ $\rho_o = 0.547$, from Fig. 2 or 0.168

(3) $\rho_o = 0.547$

$r = 0.6$

$$\left(\Psi(\rho_o) - \frac{rR}{\alpha(p)}\right) = \left(0.168 - \frac{0.6 \times 1106}{5690}\right)$$

$$= 0.051$$

$(1-\rho_w-\rho_o) = 0.76 - 0.547 = 0.213$

(4) Substituting in the final equation as explained in step 3, (1):

$$\frac{d\rho_o}{dp} = \frac{(0.547)\,(3.98 \times 10^{-4}) + (0.231)\,(9.13 \times 10^{-4}) + (0.051)\,(0.547)\,(37.7 \times 10^{-4})}{1 + \frac{0.54}{0.0165}\,(0.051)}$$

$$= 1.94 \times 10^{-4}$$

$\Delta\rho_o = (1.94 \times 10^{-4})\,(100) = 0.0194$

$\therefore$ the new ρ_o @ 1500 psi = 0.547 − 0.0194 = 0.528

(5) Cumulative recovery @ reservoir pressure of 1600 psi.

$$\text{cum. rec.} = \left(\frac{\rho_o}{\beta}\right)_i - \left(\frac{\rho_o}{\beta}\right)$$

$$= 0.47 - \frac{0.547}{1.485} = 0.099$$

Results

The results of a series of such calculations as applied to a reservoir are shown in Figure 3, where the reservoir performance is predicted for primary depletion and two separate pressure maintenance programs. In Figure 3 the reservoir pressure decline and gas-oil ratio are plotted against cumulative stock tank recovery, in percent of pore volume.

In the cases of pressure maintenance, the decrease in the rate of pressure decline is shown with the greatest arrestment being realized where 60 percent of the produced gas is returned to the reservoir. An early drop in gas-oil ratio results from the calculations in the region of 1 percent pore volume recovered, although it does not show here because of the small scale employed. This phenomenon is caused by the decrease in the volume of gas held in solution as the saturation pressure is passed and before

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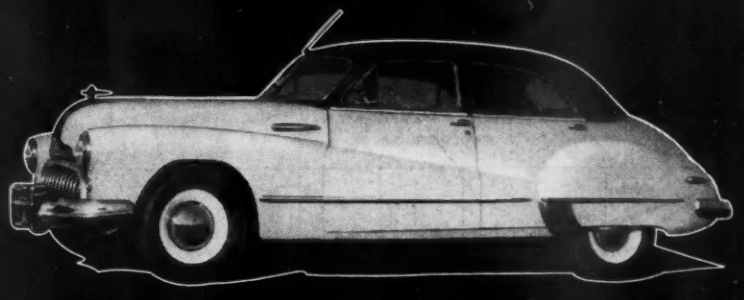

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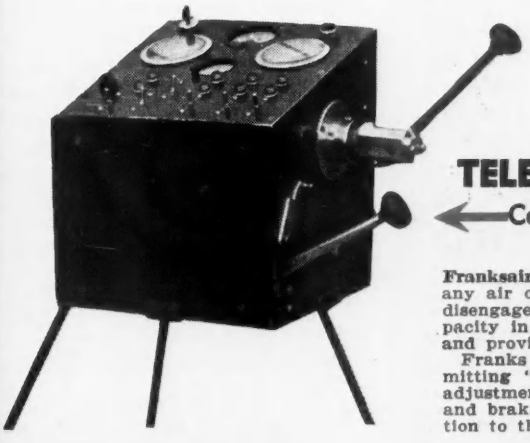

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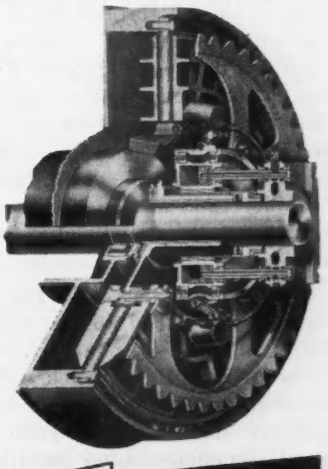

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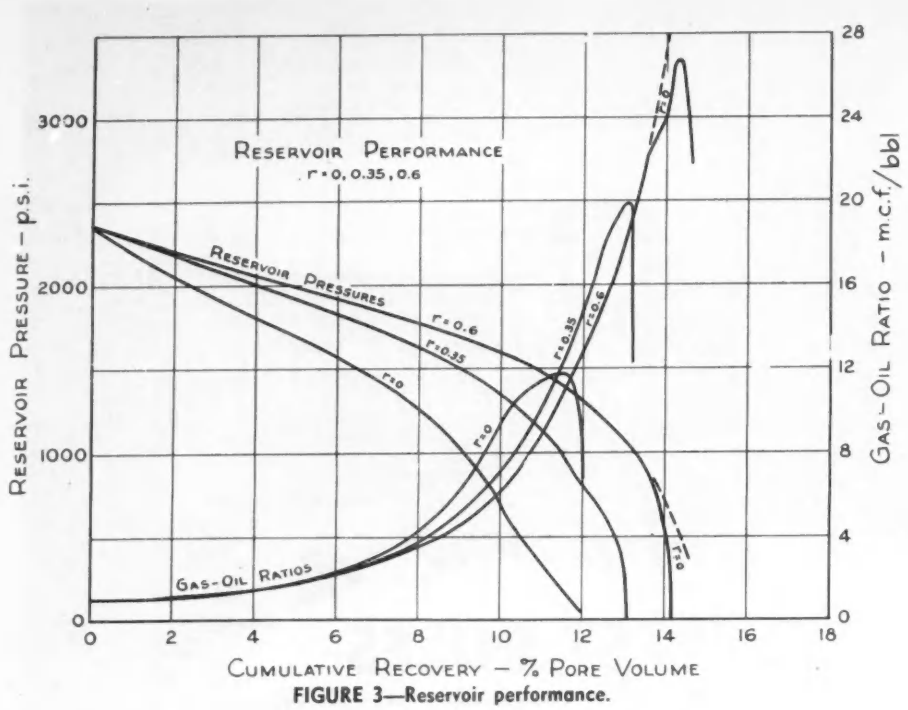

FIGURE 3—Reservoir performance.

a significant permeability to gas has developed.

The close agreement of the three gas-oil ratio curves to 6 percent pore volume cumulative recovery is explained by the fact that the effect of decreased permeability to gas in the cases of pressure maintenance is offset by the increased volume of gas held in solution at those higher pressures. Between 6 and 13 percent pore volume cumulative recovery, the beneficial effect of pressure maintenance is again evident, in that the more intense the pressure maintenance program, the lower the gas-oil ratio. That is, with pressure maintenance at the same recovery as realized under primary depletion the volume factor is higher, causing the gas permeability and hence the gas-oil ratio to be lower. Also, the increased oil mobility at these higher degrees of saturation facilitates movement of the oil through the formation, and thus assists in reducing gas-oil ratios. In the region beyond 11 percent pore volume cumulative recovery, the gas-oil ratio values for pressure maintenance rise rapidly because of the rapidly increasing magnitude of the relative permeability ratio and the larger standard volumes of gas contained in the reservoir.

The case of 35 percent of the produced gas being returned to the reservoir is shown since it is the largest percentage of the produced gas which can be continuously injected without exceeding an economic limit of 20,000 cubic feet per barrel sometime during the life of this example reservoir. In the case of 60 percent of the produced gas being injected, pressure maintenance was discontinued when the gas-oil ratio reached 22,000 cubic feet per barrel, and the equations for primary depletion used to evaluate this program for the remainder of its producing life.

The data used in plotting the curves in Figure 3 are summarized in Table 1.

Table 1

Recovery Method	Cumulative Recovery Stock Tank Oil Percent Pore Vol.	Average Gas/Oil Ratio Cu.Ft./Bbl.	Maximum Gas/Oil Ratio Cu.Ft./Bbl.	Abandonment Pressure Psig.
r=0	12.2	5,595	11,810	50
r=0.35	13.1	9,262	19,900	300
r=0.6	14.1	13,441	26,800	300

The results obtained in the manner here illustrated apply to any unit pore volume having the stated porous medium characteristics. Because of the wide variation in porosity and permeability observed in many producing sections, it is realized that all parts of the reservoir will not be equally susceptible to pressure maintenance by gas injection. Calculated results can sometimes be adjusted to more realistic estimates of expected recovery by assuming recovery under pressure maintenance to apply only to that fraction of the reservoir pore volume of sufficient porosity and permeability to diffuse injected gas, and by considering the remainder of the reservoir to produce by primary means. A method has been suggested by Patton[3] for incorporating a conformance factor equal to the decimal fraction of the reservoir pore volume producing under pressure maintenance into pressure maintenance equations similar to those developed here.

The selection of a suitable conformance factor is difficult at best, and requires as thorough a knowledge as possible of the lithology, core data correlation from well to well, and history of the reservoir development and production. The engineering judgment necessary to even qualitatively estimate such a factor can probably be applied with equal acuracy to the interpretation of the results of calculations where one hundred percent conformance or complete diffusion of injected gas is assumed.

Conclusion

Solution gas drive reservoir performance under various withdrawal programs can be predicted in this manner, and can be placed on a time basis by assuming reasonable future withdrawal rates. Comparative economic analyses can then be made and the most profitable withdrawal program determined.

ACKNOWLEDGMENTS

Appreciation is extended to Dr. H. H. Power of the University of Texas for his encouragement and advice during the preparation of the thesis from which the original paper was taken, and to Dr. M. Muskat of the Gulf Research and Development Company for his suggestions on the derivation of his equations used herein.

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About the Author

ROBERT L. HOSS graduated in petroleum engineering from the University of Tulsa in 1942, and was employed by Phillips Petroleum Company during undergraduate summers and full time until 1943, when he left for military service, which included two years in Africa and the Middle East with the U. S. Army Air Corps. Following his discharge in 1946, he obtained an M.S. degree in petroleum engineering from the University of Texas. He was with Kewanee Oil Company until June, 1947, when he joined Humble Oil & Refining Company.

STUDIES IN Relative Permeability

By J. H. HENDERSON
and S. T. YUSTER
The Pennsylvania State College

QUESTIONABLE RELIABILITY of the conventional conductivity methods for determining saturations of core samples led to the development of an apparatus which gave direct effective permeabilities at equilibrium saturations. This paper, one of those presented at the Eleventh Annual Secondary Recovery Conference at The Pennsylvania State College, is another of the series on core and reservoir studies being presented by WORLD OIL.

A METHOD of measuring relative permeabilities on small core samples was recently reported by this laboratory.[1] As a result, inquiries have arisen regarding the experimental apparatus and the technique used. This paper is to present briefly some theoretical implications of the method, to elaborate on the apparatus and the experimental procedure, and to present typical data collected to date.

Introduction

Various theoretical phases of the field of petroleum production require data on relative permeability of the porous media to the flowing fluids. Comparatively simple laboratory techniques for obtaining this information on small core samples have not been available until recently. Moreover, most of the published data have been gathered using large core systems which often were not oil sands. The method to be described herein uses sand samples obtainable by conventional coring methods, and provides a wide range of conditions under which flow data may be gathered.

It may be well to define just what is meant by relative permeability. Using the nomenclature designated by API Code No. 27,[2] the following terms will be used: (1) permeability, which will be understood to be that as determined with a single, homogeneous, liquid phase present; (2) effective permeability, which will refer to the permeability of the core to one phase when two phases are present; and (3) relative permeability, which as applied to one fluid phase, at any definite percentage saturation of that phase, is the ratio of the effective permeability to the permeability.

Symbolically:

$$K_{ro\ (\%o,\ \%w)} = \frac{K_{o\ (\%o,\ \%w)}}{K}$$

Systems involving three phase equilibrum are excluded from discussion in this work. Similarly, it is not within the scope of the report to deal extensively with the application of relative permeabilities once they are obtained. It will suffice to point out that in virtually every prediction of reservoir production behavior, some estimate must be made of the fractional permeability of the porous medium to the fluids present. Heretofore, such prediction has been based largely on the air permeability of core samples in conjunction with often rather sketchy knowledge of past field performance. If reliable experimental relative permeability curves can be provided which are characteristic of a field or sector of a field, predictions of reservoir behavior will rest on a much firmer foundation than in the past.

Particularly interesting to those operating secondary recovery projects using a water drive is the information which may be derived from the effective permeabilities at the equilibrium saturations. The data from a relative permeability test include the residual oil saturation expected of an efficient water drive, and also the irreducible water saturation, which should be an indication of the original connate water saturation. These data in conjunction with good core analysis should permit accurate predictions of water intake and oil production rates. In addition, the method of measurement promises to provide additional information on the flow behavior of fluids at or near the flood front, where essentially 100 percent liquid saturation may be safely assumed. There is also the possibility that with the collection of data on many sands whose field performance under water drive is known, a reliable criterion of field responsiveness to water flooding may be developed.

Theoretical Discussion

Briefly, the concept of relative permeability has given rise to two major assumptions regarding multiphase simultaneous flow through porous bodies: one, flow of one phase only through a given capillary of series of capillaries at any one time; two, the simultaneous flow of two immiscible fluids through one capillary channel.

If the first condition holds, and the system behaves as a bundle of parallel, disconnected capillaries, the fluid with which each is filled will depend upon the interfacial tension of the two fluids present, the diameters of the capillaries, and the preferential wettability of the surfaces, for the fluids involved. Then it might be expected, as pointed out by Leverett,[3] for the relative permeability curves to be straight lines, 45-degree diagonals on the conventional relative permeability of K_r vs. S. The fact that the relative permeability curves for actual sands do not follow such a pattern is dismissed by citing the action of interfacial forces active in the interstices of the sand.

In this connection, it is interesting to note the work of Putnam, Martinelli and Lockhart,[4] who have published relative permeability curves for gas-liquid viscous flow in a single glass capillary. Here, if anywhere, it might be expected that the K_r curves would be 45-degree diagonals since there are no interstices to sidetrack any portion of the liquid and thus interfere with flow. Instead, the curves rather closely resemble the conventional curves presented by Wycoff and Botset[5] for consolidated and

unconsolidated sands. Here then is a suggestion that placing the responsibility for the low effective permeability of a sand containing two immiscible phases, solely on the trapping of a portion of fluid in the interstices may not be completely justified.

To return to the question of the flow picture, the second possible mechanism is that simultaneous flow of two immiscible fluids occurs in a single capillary. This of course can occur in two primary ways: (1) flow of both fluids in parallel and perhaps annular paths; or (2) some form of slug flow. This latter is virtually excluded from a knowledge of the difficulty of initiating this type of flow by artificial means. The former is difficult to visualize as occurring to any great extent in a natural sandstone, particularly of the consolidated type having very small interconnected pores.

A flow picture more compatible with our present knowledge of fluid behavior would be a combination of the two described above, with the former playing the major role. It is this type of flow pattern that the relative permeability apparatus is believed to provide.

For example, visualize an oil and water mixture under a given pressure contacting the face of a water-wet sand. It seems logical that the water would penetrate the pores of the sand under a driving head composed of the applied pressure plus the capillary pressure of the sand. The oil would penetrate those pores whose openings at the sand face were of sufficient diameter to have a displacement pressure less than the applied pressure on the oil phase. Here is a condition fulfilling the restrictions of the first possibility cited above; flow of the non-wetting phase in those capillaries of sufficient diameter to permit its entry, and simultaneous flow of the wetting phase in those capillaries of smaller diameter.

Project this picture a short distance into the body of the sand. Might there not be a combination of the two, with some of the capillaries which at the fluid source selectively permitted the flow of oil, here discharging into capillaries containing brine, droplets of oil, or perhaps even a small stream of oil?

Similarly, it can be visualized that a capillary, which, although permitting the entry of oil, will not permit its flow past a point at which the diameter of the pore has diminished to such an extent that the applied pressure on the oil phase will not exceed the pressure drop across the brine-oil interface at the constriction.

Any number of circumstances can be suggested as occurring within a non-homogeneous porous medium. The above were cited only to emphasize the complexity of the physical analysis which will be necessary in any attempt to thoroughly explain the result of relative permeability measurements.

The equipment used in the measurement of relative permeability meets three primary objectives: (1) it makes possible the use of small consolidated core samples obtained by conventional coring methods; (2) simultaneous flow of two fluids in various ratios may be maintained; and (3) necessary measurements of pressure drop, flow rates, and saturations are possible. In addition, and perhaps of equal importance, means are provided for determining the existence of steady-state conditions, eliminating the end effect, and providing for an even distribution of the multiphase complex throughout the core cross-section.

Plates 1, 2, and 3 show in some detail the apparatus used. Plate 1 is a front view of the C-clamp used to hold the three core sections used. Plate 2 is a top view of the C-clamp, and an enlarged view of the three core sections in the respective positions they occupy during test. Plate 3 is a diagram of the reservoir system from which the test fluids are injected into the core assembly.

Exclusive of the clamping device, the over-all picture of the apparatus is this: First, a reservoir system from which controlled ratios of test fluids are injected into the mixing head of the core assembly. Here they are evenly distributed through a section of the same sand as that being tested. The outlet

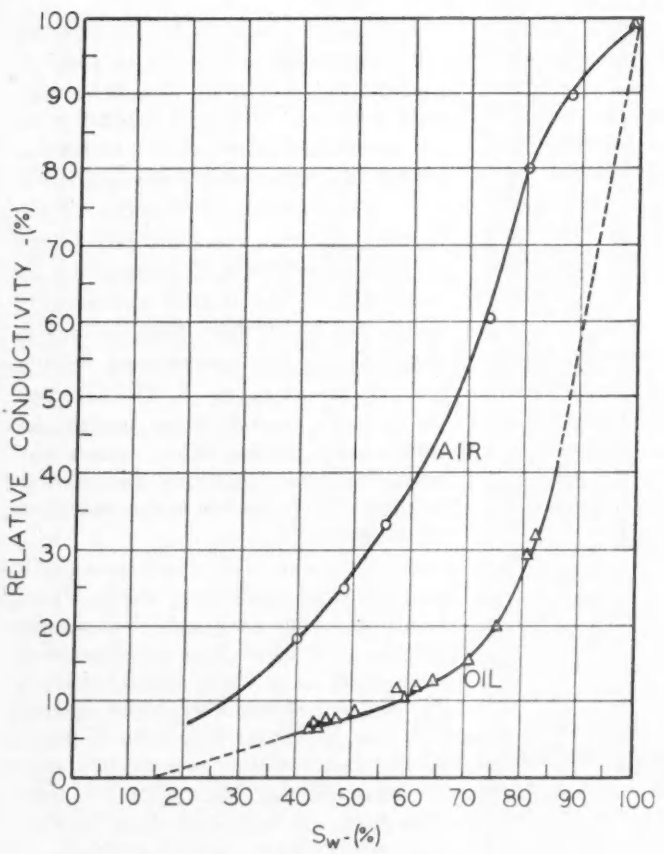

FIGURE 1. Relative conductivity vs. brine saturation, Bradford core 27-BT-3.

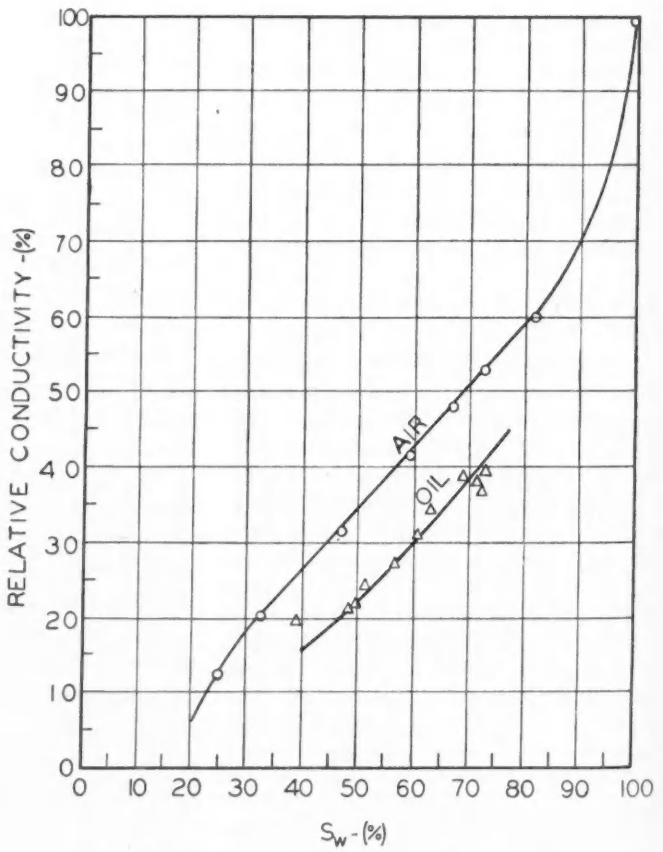

FIGURE 2. Relative conductivity vs. brine saturation, Venango core B-4-A.

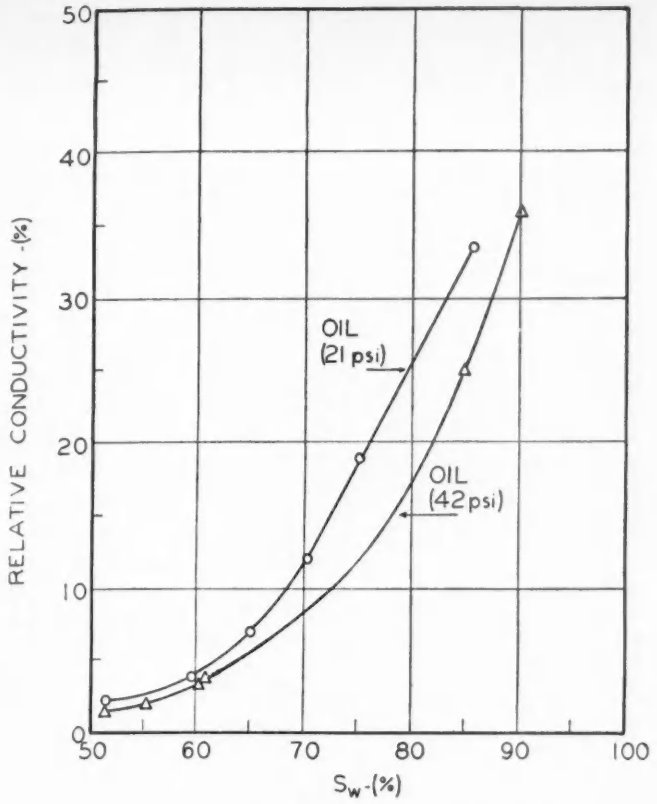

FIGURE 3. Relative conductivity vs. brine saturation, Bradford core 9-KS-1.

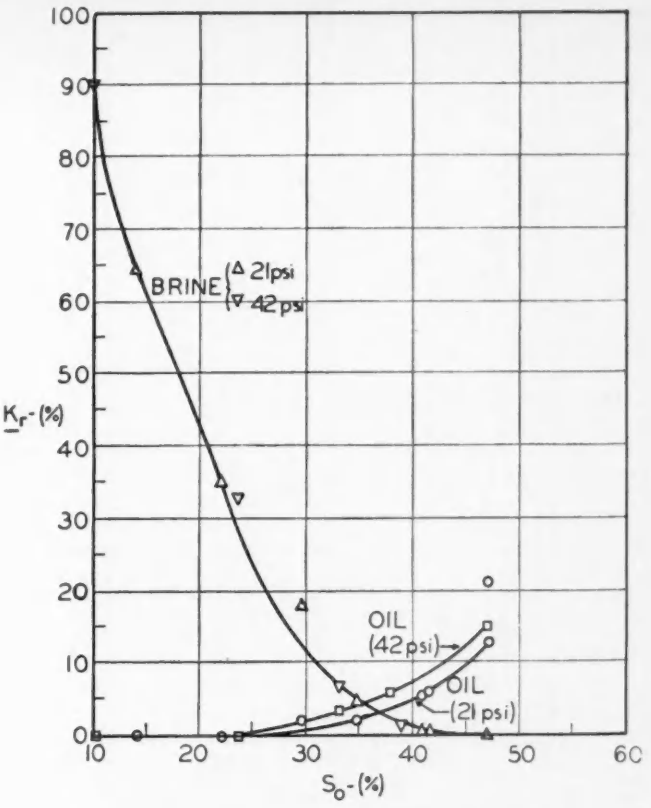

FIGURE 4. Relative permeability, Bradford core 9-KS-1. K_r vs. S_o.

face of the mixing head section contacts intimately the inlet face of the core section upon which permeability determinations are to be made. The outlet face of the test section in turn intimately contacts the face of the outflow section, also composed of sand from the same core sample.

The clamping device and the reservoir system need no explanation to supplement the diagrams. Embodied in the core assembly, however, are three features which have prompted considerable inquiry. These are the mixing head assembly, the sand face contact with the Lucite-Lucite seal, and the method of measuring pressure-drop across the core.

Before discussing these topics in detail it may be well to point out the conditions to which the cores are subjected during the mounting procedure. All three sections of the core assembly are mounted in Lucite (a Methylmethacrylate polymer) by compression molding in a 1¼-inch diameter cylindrical mold. It has been found feasible to mount these cores using a pressure of 1500 pounds per square inch and a temperature of 100 degrees C. This has permitted mounting the most friable of the Bradford sands which heretofore have failed in compression under the higher pressures formerly used. No appreciable penetration of the Lucite occurs. The inlet chambers, shown in the diagram of the mixing head, and the outlet chamber were originally obtained by mounting a magnesium disc in the Lucite and subsequently dissolving it out with dilute acetic acid. In place of the magnesium, small discs of compressed salt are now used which are easily dissolved out with fresh water.

Mixing-head section: This section of the core assembly, in which the simultaneous flow of two fluids through the sand is established, is shown in some detail in Plate 2. The essential elements are the inlet chambers, the two synthetic sandstone discs separated by foil containing a 1/16-inch orifice and the short section of the same sand as the test core. With this arrangement it has been possible to provide an even distribution of the two phases as they emerge from the mixing-head assembly and flow into the test core.

In the measurement of relative permeability on small core samples three major stumbling blocks occur: (1) assurance that the saturation is the same throughout the test core; (2) determining the saturation of the test section after equilibrium conditions have been established; (3) measurement of the pressure gradient across the core due to the flow of the fluid.

The core assembly is designed to give an even saturation distribution throughout the test section, with no end effects which might interfere with the rate of fluid flow. To accomplish this the core sections are so prepared that they may be forced into such intimate contact with each other that the surface forces of the fluids will maintain a homogeneous saturation distribution from one core section to the adjacent section. There must be no pressure discontinuity in either phase due to the break in the sand body.

In order to do this the cores are machined as follows: The sand face is first ground to a flat surface with a tool grinding attachment on a machine lathe, and the Lucite sheath is then machined until it protrudes past the sand face 0.00050 inches. Each of the four exposed sand faces is treated in this manner. Thus, to allow the sand surfaces to be in absolute contact, each pair of Lucite ends must compress a total of 0.0010 inches when placed under the compressive stress in the C-clamp. In addition to placing the sand surfaces in intimate contact, this method has provided a Lucite-Lucite seal which has proved leakproof under working pressures up to 45 pounds per square inch.

The ideal apparatus would permit the accurate determination of spot saturations throughout the test section at any instant during a flooding test, without disturbing any portion of the apparatus. As an approach to this condition it was originally hoped that a method of measuring the resistance of the test fluids to the flow of an electric current would provide such a measure of core saturation. Botset[5] and Leverett[3] used a similar method of saturation determinations in their early work on relative permeability, using a calibration curve constructed

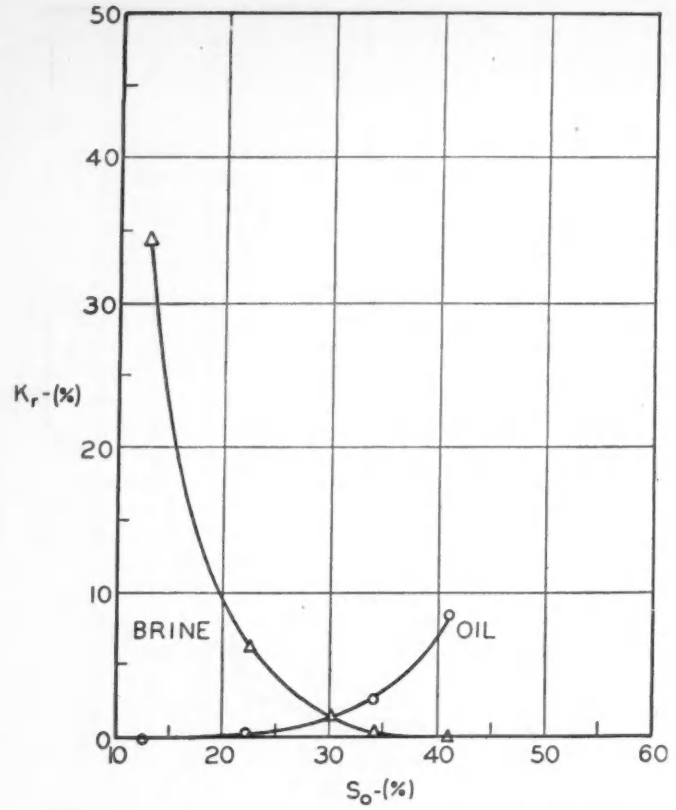

FIGURE 5. Relative permeability, Bradford core 27-BT-3, K_r vs. S_o.

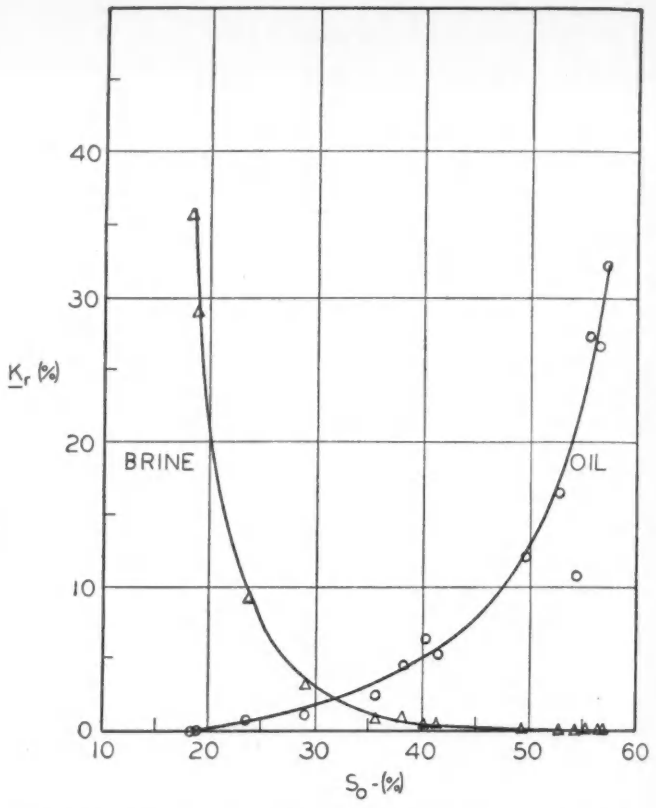

FIGURE 6. Relative permeability, Bradford core 27-BT-3, K_r vs. S_o. (Core treated with HCl).

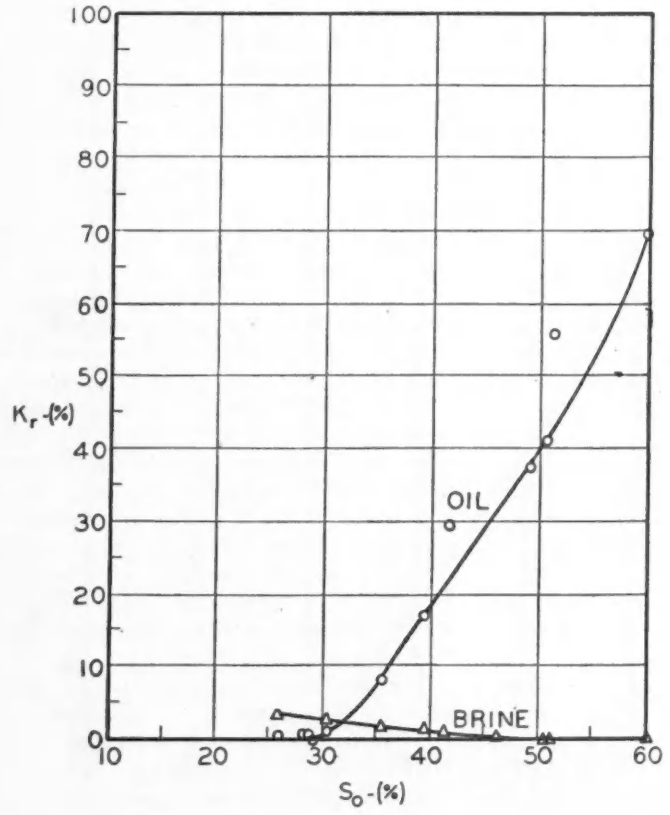

FIGURE 7. Relative permeability, Venango core B-4-A, K_r vs. S_o.

from weight balance saturation determinations of a small sample of sand, independent of the sand body upon which flow tests were conducted. Unfortunately, this conductivity method of saturation determination did not prove feasible in the work on actual reservoir sands, as will be pointed out later. The actual saturations were determined by weighing the test section of core on an analytical balance. As is evident from a study of Plate 2, the test section of the core may be removed from the system almost instantaneously, simply by releasing the clamping device. This permits the core to be removed, weighed and returned to the flow stream in a very short time.

The measurement of the pressure gradient across the core section has been accomplished in the following manner. A study of Plate 2 shows channels through the Lucite leading to the machined faces of the end core sections. Across these openings in the core mount a mercury manometer is connected using capillary tubing, and with water over the mercury transmitting the pressure fluctuations from the core assembly to the mercury column. Pressure pickup is assured at the core end of the leads by the following method: After the sand face has been ground, as described previously, a scratch is made around the circumference of the sand body adjacent to the Lucite sheath. This assures fluid continuity and takes care of any possible Lucite penetration that may block off the manometer lead from the fluids flowing through the sand body. A small channel cut in the machined Lucite surface of each end section connects this circumferential scratch with the manometer lead.

Considerable discussion has revolved around this method of pressure measurement because of its failure to employ diaphragms containing 100 percent saturation of a given phase. Pressure-drop measurements using saturated porous diaphragms are, of course, intended to measure the pressure drop in one phase only. Presumbaly, the advantage in measuring the pressure drop in each

of the phases present is that it relieves the ambiguity in the present method of calculation, in which the same pressure drop across the core is used in the calculation of both the permeabilty to oil and the permeability to water.

To state that the pressure drop in the two phases is unequal, assuming the medium to be homogenous, is tantamount to stating that the saturation ratio of the two phases varies from the inlet end to the outlet with the non-wetting phase being at its highest saturation at the inlet end of the test section and at its lowest at the outlet end. If the pressure drop in each phase is different, then perhaps a major requirement of a reliable apparatus has not been attained, that of homogeneous saturation distribution throughout the sand body. In the case of the apparatus described, assuming the sand face contact serves the intended purpose of preventing a pressure discontinuity in a given phase across the break, then the only saturation gradient which occurs through a homogeneous core will be one from inlet to outlet due to the pressure drop across the core creating flow. That is, the non-wetting phase, at the inlet end of the core, because of the higher absolute pressures existing there, may occupy pores of smaller size than at any point downstream, simply from a consideration of interfacial tensions and capillary radii.

It is difficult to visualize how a homogeneous saturation distribution can be obtained in a small core sample if on various points on the sand surface an arbitrary 100 percent saturation of a given phase is imposed by the use of selectively-wet porous diaphragms. In a small core sample it is almost mandatory that these diaphragms occupy an appreciable proportion of the core surface, in fact, they often are placed on the face of the sand body through which flow must occur. Certainly, here, they impose an artificial saturation distribution on the pore structure.

With the present setup, the likelihood of a discontinuity of saturation distribution due to the pressure taps is believed to be minimized. Contact of the manometer leads with the fluid in the core is through a very small cross-section of free liquid. The manometer system involves no flow after equilibrium is established. The core itself has the freedom to determine which fluid, or ratio of fluids, shall exist in this pressure tap. Surely, it will be one which will create a minimum of disturbance in the equilibrium of the saturation distribution.

There is undoubtedly a place in the academic development of relative permeability measurements, and the attempt to understand completely their significane, for a single phase ΔP measurement. If accomplished without severely

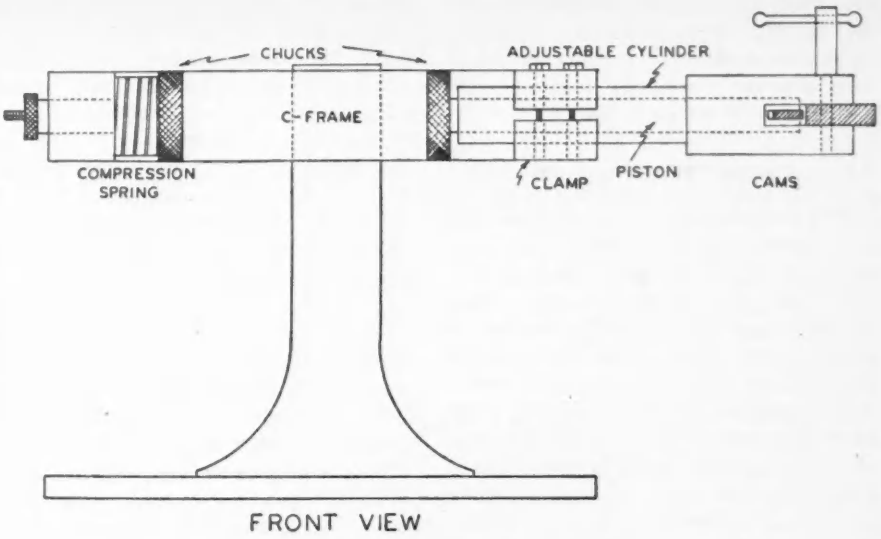

PLATE 1. Relative permeability apparatus.

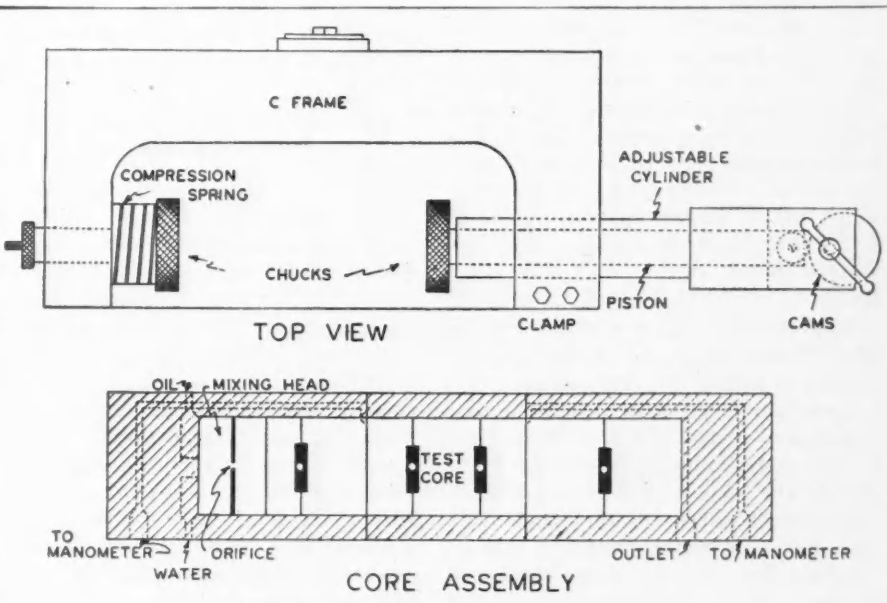

PLATE 2. Relative permeability apparatus.

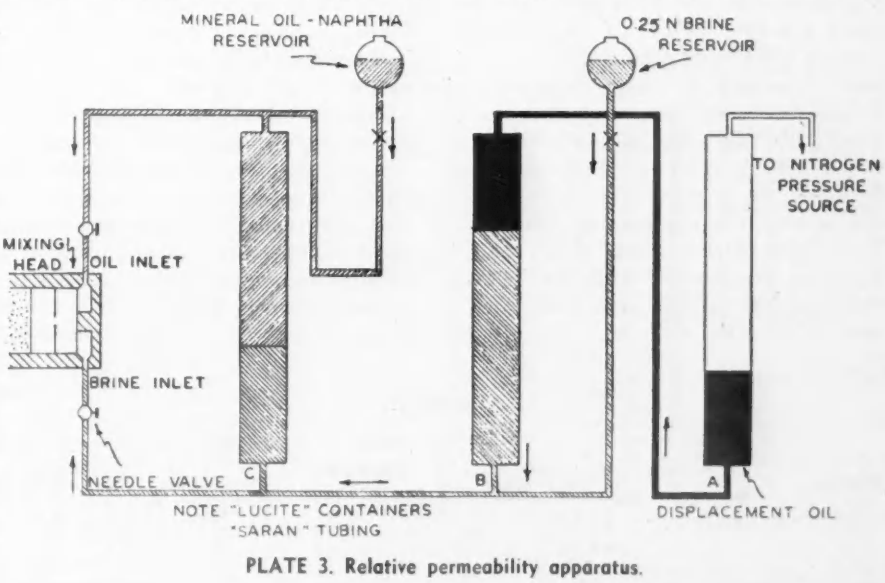

PLATE 3. Relative permeability apparatus.

disturbing the saturation distribution of the flowing system, it should provide important evidence regarding any possible saturation gradient in conjunction with the pressure drop, due to flow.

Typical Test Procedure

The procedures used in the actual test are largely a matter of laboratory technique. However, there are a few features which are of considerable importance. Among these are the initial saturation of the core sections, the sequence of flooding operations, and the saturation determinations themselves. It also might be well to mention here that the role of the machinist in the preparation of the core assembly is of the utmost importance. Carelessness in this phase of the preparation will result in an imperfect sand-sand, Lucite-Lucite contact which will necessitate regrinding of the sand surfaces.

Attaining a 100 percent saturation of one liquid phase in initiating a test is of utmost importance. Any gas saturation will invalidate the subsequent weight-balance saturation determinations. The technique used in these tests is to clean and dry thoroughly the core assembly to a constant weight; apply a vacuum of 1 to 2 mm Hg. to the system; with the vacuum pump still in operation inject the liquid into the core under a pressure of approximately 75 pounds per square inch. When the liquid appears at the evacuated end of the core assembly, the vacuum pump is removed and the system flowed under a back pressure until several pore volumes have been produced. The weight of the core is taken immediately after saturation and again after being in contact with the saturating fluid for a period of several hours. If water is the saturating liquid, as it usually is, the core will have gained several milligrams. This weight is used as the 100 percent liquid saturated weight for subsequent saturation determinations while the first weight of the saturated core is used in checking the pore volume. This gain in weight is accredited to the absorption of water by the Lucite cast. This effect has not been detected when oil is used as the saturating medium.

Consider the sequence in which the fluids are injected into the core. A standard practice has been as follows: Saturate 100 percent with brine; determine the pore volume and constant saturated weight; flood the core with the oil phase to the minimum residual water saturation; repeat with a brine flood carried to the minimum residual oil saturation; then determine the behavior fllowing various ratios of oil and brines at core saturations between the two equilibrium points. Variation of the flooding sequence has been tried, but the above brine-oil, brine-complex sequence has given the most troublefree operation.

The saturation determinations themselves are largely a matter of operational skill. After equilibrium has been established (as indicated by a constant ΔP across the test core and the constantcy of the resistance reading of the conductivity bridge), the flow rates are measured, the C-clamp is released, the test section quickly removed, weighed on an analytical balance and returned to the flow stream. In the reinsertion of the test section into the flow stream, extreme care must be exercised to make certain no air is forced into the sand section.

Data and Conclusions

As was cited previously, the conventional conductivity methods of determining saturations did not prove satisfactory. The reason for rejecting this method of saturation measurement becomes evident with a glance at Figures 1, 2, and 3. These curves are all calibration curves of brine saturation versus relative electrical conductivity. Figures 1 and 2 each show two calibration curves for a single core. The curve labeled air is for a system during the displacement of brine with air. The curve labeled oil is for a displacement of brine by oil. Visualize the results if the air-brine calibration curve is used for the saturation determinations during an oil-brine relative permeability test. Similar pairs of curves have resulted from all tests conducted on reservoir sands, and work by other investigators[4] has verified their existence for synthetic sandstone cores.

Figure 3 shows two oil-brine conductivity curves determined on the same core at two different applied pressures. In the test in question, the first curve was determined at an applied pressure of 21 pounds per square inch, the applied pressure then raised to 42 pounds per square inch. This gave the conductivity curve a decided lateral shift. Here is the first definite concrete evidence that the pressure drop across the test section may provide some sort of a unique saturation distribution pattern, perhaps one similar to that suggested in the previous discussion. In general the shape of the relative conductivity curves is similar for all cores tested, although no two cores gave curves which could be termed "like." The conductivity measurements then serve the following purpose. A constant resistance reading during a flood is a valuable indication that steady-state conditions exist. Once a curve is established for given test conditions of temperature, applied pressure, and brine normality, the curve may be used for saturation determinations during that particular test only. It is emphasized that the curve must be well established by weight saturation determinations before this is possible.

Relative Permeability Curves

Figures 4, 5, 6, and 7 show typical results of the relative permeability tests described above, on natural consolidated sand cores. Pertinent data for the cores are shown in table below.

Understanding the significance of the curves shown is difficult, if the conditions imposed upon the core during the test are not known. For this reason each pair of curves will be discussed briefly to point out what are believed to be the salient features.

All the curves presented were determined using the flooding sequence described previously, in which the core is initially 100 percent brine saturated. This sequence of flood his been found to be most applicable from a practical standpoint. Reversing the flood sequence, that is, flooding the dry core first with an oil phase, has not altered the type of curve materially. The maximum effect noted was a shift of the entire picture latterly appromixately 4 percent along the saturation axis in a direction which increased the oil saturation for a given pair of K_r values.

First consider the curves of Figure 5 on a Bradford and of 83 millidarcys permeability. These curves show a residual oil saturation of 13.5 percent and an irreducible brine saturation of 43 percent. Two facts immediately attract attention: (1) the very high irreducible water saturation; (2) the very low K_{ro} at this saturation. As subsequent figures show, all Bradford sands tested have shown these two characteristics. It was first thought that they were perhaps partially due to the fixed flooding history to which the cores were subjected. To check this the flooding sequence was reversed, the initial flood being 100 percent oil. After the oil-brine complex was

TABLE 1

Figure	Core Designation	Reservoir Sand	Permeability	Effective Porosity—(%)
5	BT-27-3	Bradford 3rd	83md	20.2
6	BT-27-3 (acidized)	Bradford 3rd	105	22.4
4	9-KS-1	Bradford 3rd	105	23.0
7	B-4-A	Venango	148	20.2

established in this manner, the same type of curves resulted as with the standard procedure described previously.

Figure 6 shows relative permeability curves determined on the same core as those of Figure 5 after treatment of the core with hydrochloric acid. The main feature to be noted here is the increased oil permeability and the decrease in the irreducible brine saturation by 15 percent. In conjunction with this the effect of the acid on the porosity and permeability of the core should be noted. The porosity was increased from 20.2 to 22.4 percent and the permeability from 83 md to 105 md. The purpose of acidification was to ascertain the effect of the acid on the wettability of the core. Apparently the effect was not great. At any rate, no conclusive statements may be made from this one test.

Figure 4 shows curves for a Bradford core on which tests were conducted under two different applied pressures. As was pointed out under a discussion of saturation determinations, the conductivity curves for the two pressures were different. Here it was suggested that perhaps the fluid distribution in the core might not be the same for two different applied pressures. There is a shift of the K_{ro} curve slightly upward with the higher applied operating pressure, but with the same irreducible water saturation maintained. Note that in this test the residual oil saturation is shown at 10 percent, with a K_{rw} of 90 percent. This saturation was obtained during the 42 pounds per square inch test. During the low-pressure test the oil saturation could be reduced to only 14 percent with a corresponding K_{rw} of 62 percent.

Figure 7 shows the results of an oil-brine test on a Venango sand sample. Note the reversed positions of the K_{ro} and K_{rw} curves as compared to those on all Bradford sands. Here the striking feature is the very low brine permeability at the highest brine saturation obtainable; K_{rw}, 4 percent at a brine saturation of 73.5 percent. It is the marked difference in the type of curves obtained on the two sands presented, that suggests the possibility of determining an empirical criterion of whether or not a particular sand will respond to water flooding. Obviously, the data herein do not constitute any such standard. However, we know Bradford sands will respond to an artificial water flood. We know Venango sands, in general, do not. Bradford sands have to date given a characteristic pair of curves in every test. Venango sands have given a radically different type of diagram. Correlation of field behavior and relative premeability curves on many different sands should prove very interesting in this respect.

Of what use are these data to the secondary recovery producer?

First, let us summarize the over-all picture presented by the data gathered on Bradford sands. The residual oil saturation after a brine flood of an oil-brine complex is in every case very low. In Figure 4 note that the residual oil saturation is below 10 percent of the pore volume. Of course, the pressure gradient across the core is fantastically great in comparison to field conditions (up to 130 pounds per square inch/foot) and the conditions of water injection ideal, many pore volumes of brine being flowed through the core to attain the residuals shown. Herein may lie a clue to the reason for the higher residuals reported on field tests of sands subjected to floods. As was indicated previously when a lower pressure gradient is used in the laboratory tests the residual oil saturations are higher. If a gradient comparable to that used in actual flooding operations were used, it is conceivable that oil residuals comparable to field values would result.

Now consider the equilibrium saturations of the water phase. Here the results do not fit in so well with field behavior. The irreducible water saturations are high, very high, in every case. The lowest obtained on a Bradford sand to date is 43 percent brine, and this on an acidified core, which may have had the pore structure altered considerably. The more usual order of magnitude is from 50 to 55 percent brine. These data do not substantiate core analysis data which place the original connate water saturation of the Bradford sand as being much lower. Neither do they help to clarify the high virgin oil saturations reported from portions of the field. At no time during any of the relative permeability tests has it been possible to force more than 57 percent oil into a core after it had been brine flooded. This is true of cores up to 105 md. permeability, regardless of which phase constituted the initial saturation. Here is a suggestion that pore size distribution may have an important bearing on the magnitude of the percentage of pore space into which oil may be forced under a given applied pressure. A test on a five md. core (14 percent porosity), using 45 pounds per square inch applied pressure, resulted in an irreducible brine saturation of 70 percent. This taken in conjunction with the fact that the 30 percent oil was very easily removed by subsequent brine flood, indicates a physical distribution of pores which presents very few capillaries of sufficient diameter to permit the entry of oil, and many very fine capillaries saturated with the wetting phase, brine.

These results do not mean that either the laboratory or the field analyses are not reliable. Rather they serve to emphasize the importance of understanding the way in which the data are obtained, and for what they may be used. Looking at the statistics alone it might be asked: How can the Bradford field have spot oil saturations of 50 to 60 percent, if in the laboratory, it is barely possible to force this quantity of oil into the sand. It must be remembered that the relative permeability tests are conducted with only two phases present. It is quite likely, indeed quite certain, that if the water content is reduced below its equilibrium saturation with a gas drive, the core will accommodate a higher percentage of the oil phase. The behavior of these cores under only two phase saturation may also place some limitations on just what conditions existed when the oil now in the Bradford sand came into being. It is difficult to understand how it could have migrated into the sands in such quantities under conditions of 100 percent liquid saturation. Such considerations suggest that the use ofirreducible water saturations as a measure of the original connate water saturations of the Bradford sand may be in error.

Previous indications that the Bradford sand may be oil wet are not borne out by a consideration of the residual oil saturations obtained on a number of tests. Note that in the test data presented on Bradford cores, the residual oil saturations are low in every case; in one case only 10 percent of the pore volume. On tests of Bradford sand of lower permeability than those shown the residuals have been even lower. Another factor to consider in this respect is that in those tests in which oil was the initial satur ting phase, the irreducibel brine saturation was again very high. This would indicate that the brine had displaced most of the oil phase from the small interconnecting pore spaces.

ACKNOWLEDGMENT

This report covers a portion of the research program on the Secondary Recovery of Petroleum sponsored by the South Penn Oil Company of Bradford, Pa., in the Division of Petroleum and Natural Gas Engineering at The Pennsylvania State College. The encouragement and suggestions of the engineers of the South Penn organization are gratefully acknowledged. Appreciation is also expressed for criticisms and discussions offered by members of the college staff, particularly those of K. W. Smith.

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Condensate PRODUCTION AND CYCLING

Part 14

Economics of Condensate Production

THE economics of condensate production may be on a one- or two-fluid basis. A plant operator may wish to cycle on the basis of the income from condensate only as he may not have an interest in residue gas. From the viewpoint of working interests, producing rates are based on a current income from condensate and either a simultaneous or a deferred income from gas utilization. Procedures for estimating the optimum rate of production are indicated. The optimum rate of cycling relative to condensate and residue gas may be 50 percent higher than the optimum relative to condensate alone.

By PARK J. JONES
Consultant

Plant Investment and Operating Expense

The plants associated with condensate production are classified as cycling, noncycling, stabilizer, compressor and water plants. The approximate plant investment and operating expense is shown in Table 14-1. The present cost of a plant equals plant investment plus the annual operating expense discounted for interest rate. The curves in Figure 14-1 show the present cost during the first ten years for various types of plants. For a 3 percent interest rate which was used in Figure 14-1, the annual operating expense times the present worth factor 33.33 $(1-e^{-0.03n})$ is the present cost of the operating expense at the end of n years.

A cycling plant is operated at a comparatively high pressure relative to either no, or some, gas sales. A noncycling plant is operated at a comparatively low pressure relative to no gas injection. Pressure may be maintained with a water plant. The extraction efficiency is taken at 100 percent for cycling and noncycling plants. A stabilizer plant is operated at a comparatively low pressure relative to no gas injection. Pressure may be maintained with a water plant. The extraction efficiency of a stabilizer plant may be (1 — 10/BPMM) times the cycling or noncycling plant extraction; that is, the comparative loss of liquid to gas may be ten barrels per million cubic feet of rich gas production.

Rich gas production by expansion plus displacement by water encroachment may require compressors on the upstream side of either a noncycling or a stabilizer plant after wellhead pressure declines to some minimum value. Operations of this type are relative to gas sales and negligible condensation in reservoirs.

Cycling vs. Noncycling

The data in Table 14-1 and Figure 14-1 are intended for quick checks on plants. As an example, consider a reservoir which contains 400 billion cubic feet of gas A. The estimated loss of liquid by condensation is 1.5 million barrels for the reservoir.

The difference in present cost over a ten-year period between 100 million/day cycling and noncycling plants is about $3,400,000. Suppose six injection wells are required for cycling at 100 million/day. The investment at $80,000 per injection well would be $480,000, making a total of $3.88 million. The present value of 1.5 million barrels at $1.8 per barrel is considerably less than $3,880,000. So the cycling of gas A is not warranted on the basis of liquid loss by condensation.

Income from Gas and Condensate

The economics of condensate production may be either on a one-fluid or a two-fluid basis. The former refers to income from a liquid alone. A two-fluid basis refers to income from liquid and gas. However, when the ratio of income from gas to that from a liquid is invariant with respect to time, the economics is, in effect, on a one-fluid basis. A declining rate of liquid production relative to a fixed rate of gas sales is on a two-fluid basis. A uniform or a declining rate of liquid production relative to deferred gas sales is on a two-fluid basis.

If two or more products are fractionated in a field, cycling operations may be on a three-fluid or even a four-fluid basis. For the purpose of this work such products as liquefied petroleum gas and natural gasoline will not be considered, that is, the source of income is from one liquid and a gas.

The Optimum Producing Rate

The optimum rate of production is the initial producing rate for which the present value of a project is a maximum. Divide the total investment in wells, plant and field systems by W the number of producing wells and obtain I the per-producing well investment. Let Q equal the daily per-well producing rate. Then a quantity

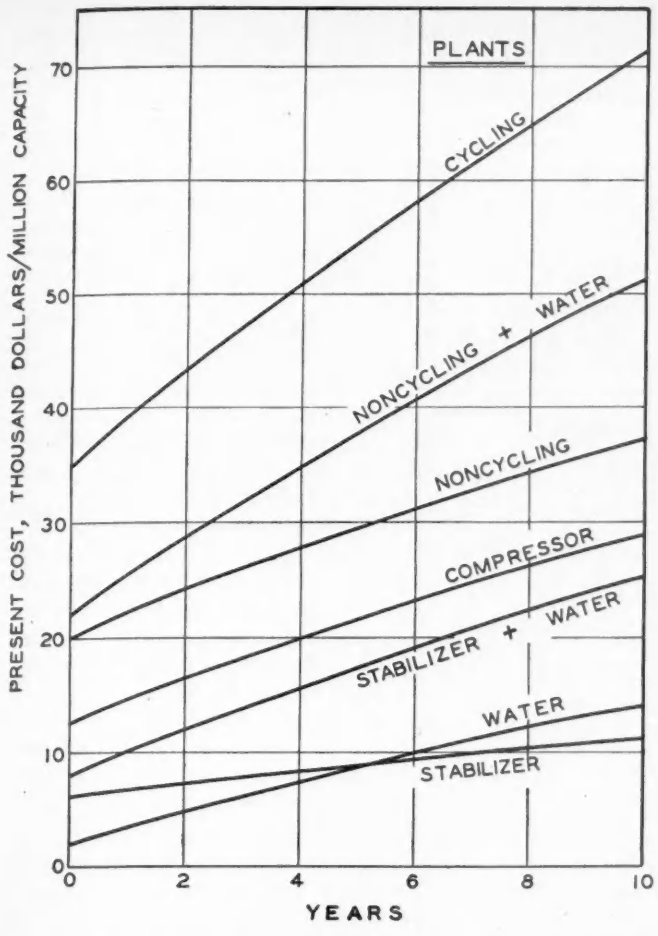


FIGURE 14-1 (top left). Approximate present cost of plant investment and operating expense water plant at 500 barrels per million; compression ratio equals three; interest rate is 3 percent.

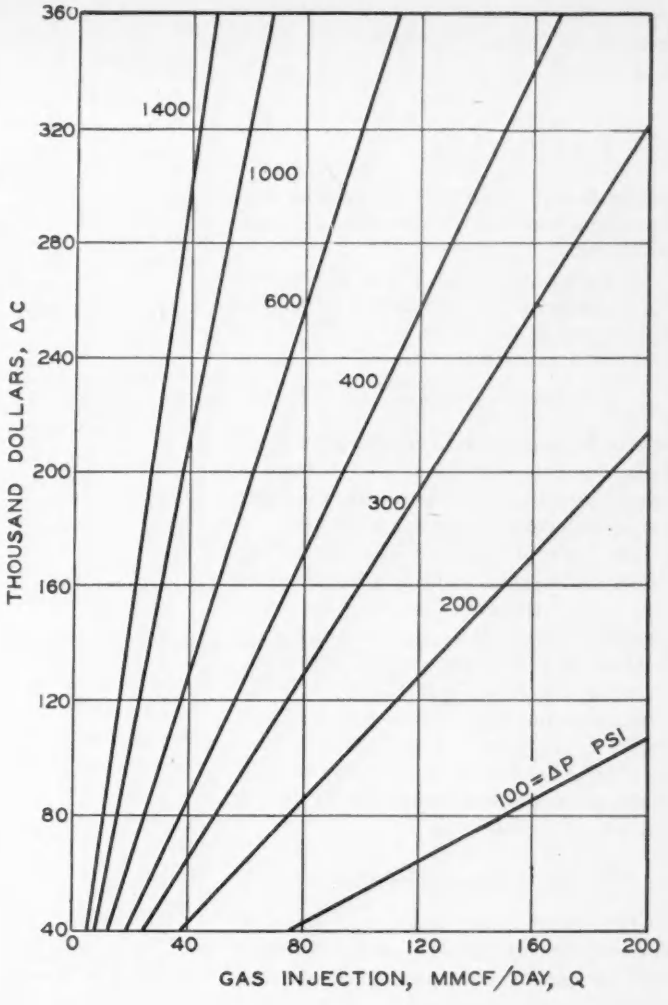
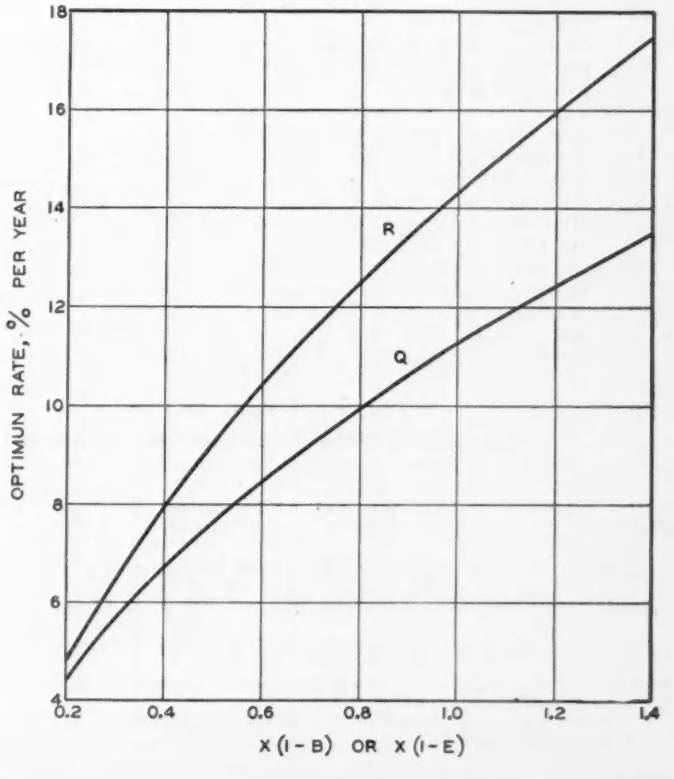


FIGURE 14-2 (lower right). The optimum rate of production Q or depletion R for uniform producing or depletion rates vs. X(1 — B) or X(1 — E); X is annual per-well producing rate divided by per-well investment; (1 — B) or (1 — E) is income after operating outgo; interest rate is 3 percent.

FIGURE 14-3 (top right). Decrease of cost $\triangle C$ of compressor service for ten years vs. gas injection rate and decrease of injection wellhead pressure $\triangle P$ by drilling additional injection wells.



$$X = \frac{365Q_w}{I} \qquad (1)$$

In which X is the ratio of the annual per-well gross income to per-well investment in dollars, barrels or Mcf's per year per dollar, barrel or Mcf invested.

Let Q equal the annual rate of production in dollars, barrels or Mcf's. Then

$$365WQ_w = IWX = Q$$

from which

$$IW = \frac{Q}{X} \qquad (2)$$

The total investment, including interest during payout, expressed as a fraction of a reserve is the present worth factor Q/X for the investment in a project.

The optimum uniform rate of production[1] is the rate Q for which

$$\frac{i}{1-\left(1+\frac{i}{Q}\right)e^{-i/Q}} = X(1-B) \qquad (3)$$

where B is the sum of taxes, royalty and operating expenses as a fraction of gross production.

The optimum initial rate of production for a uniform rate of depletion[1] is the initial rate R for which

$$R = [iX(1-E)]^{\frac{1}{2}} - i \qquad (4)$$

where E is a fraction of gross production which is equivalent to the sum of taxes, royalty and operating expenses for a uniform depletion rate.

The curve in Figure 14-2 are solutions of equations (3) and (4). The interest rate i is 3 percent. The data are on a one-fluid basis. The curves in Figure 14-2 define the optimum rate of production for a reserve recoverable at either uniform producing or uniform depletion rates. Corrections are applied[1] if a fraction of a reserve is recoverable at uniform rates and the remainder at declining rates of production.

An Approximate Rule

The exact procedure for estimating the influence of sales gas on the optimum rate of cycling is laborious. So the following approximate rule is suggested:

$$Q = \left[1 + 0.8\,\frac{bG(1-A)}{aC(1-B)}\right]Q_c \qquad (5)$$

where

- G = in place value of residue gas, dollars
- b = sales gas reserve, fraction of in place residue gas
- (1 — A) = income from sales gas after taxes, royalty and operating expenses Mcf/Mcf
- C = in place value of condensate, dollars
- a = condensate reserve, fraction of in place condensate
- (1 — B) = income from condensate after taxes, royalty and operating expenses, bbls/bbl
- Q_c = optimum initial rate of cycling aside from gas sales, fraction per year of initially in place condensate
- Q = optimum initial rate of cycling relative to gas sales, fraction per year of initially in place condensate.

As a check, estimate the present value of a rich gas reserve for the number of producing wells W required in order to cycle at the rate defined by equation (5). Then compare the result with the present values for (W + 1) and (W — 1) producing wells.

Injection Wells vs. Compressors

An economic balance may be required to optimize the gas injection wellhead pressure. The investment I for compressors is defined approximately by

$$I = 180(25R - 5)Q \qquad (6)$$

where

- R = compression ratio
- Q = gas injection rate, million/day
- I = compressor investment, dollars

Let the cycling plant operating pressure be 1800, and the wellhead pressure, P psia. Allow 100 psi between compressors and wellhead. Accordingly

$$R = \frac{P + 100}{1800}$$

and

$$I = 2.5(P - 260)Q \qquad (7)$$

The annual operating expense for compressors is about 0.15I. The 3 percent present worth factor for ten years is 8.63. Hence the present cost of a ten-year operating expense is 1.29I. The salvage value of ten-year old compressors is about 20 percent of investment. The present worth factor for ten years is 0.74. So the present value of salvaged compressors is about 0.148I. the difference or 1.14I added to 2.5 $(P_w - 260)Q$ gives C the present cost of compressors, that is,

$$C = 2.14I = 5.35(P - 260)Q \qquad (8)$$

From the viewpoint of displacing a rich gas by an injected gas, a reservoir requires a minimum number of injection wells. For instance, four injection wells may be required irrespective of any practical injection wellhead pressure. Let P_o be the highest wellhead pressure relative to the number of injection wells required by a reservoir. If additional injection wells are drilled, the wellhead pressure relative to the greater number of wells will be some value such as P. Other things equal, the drilling of an additional injection well is not warranted unless the reduction in the present cost of compressor service exceeds the cost of the well. The decrease ΔC of the present cost of compressor service over a ten-year period is defined by

$$\Delta C = 5.35Q\Delta P \qquad (9)$$

where ΔP is the decrease in operating wellhead pressure $(P_o - P)$ resulting from drilling additional injection wells and Q is the total injection rate in million/day averaged over ten years.

The lines in Figure 14-3 are solutions of equation (9). The reduction in the cost of compressor service for ten years is plotted against the total injection rate and a decrease in operating wellhead pressure. For instance at 100 million/day total injection rate, a $160,000 investment for additional injection wells is warranted only if the investment decreases injection wellhead pressure by at least 300 pounds per square inch.

Let P_s equal the shut-in wellhead pressure for injection wells. If the total rate of injection is Q and the per-well average rate is Q_o, the number of injection wells is Q/Q_o. Let P_o equal the injection pressure relative to Q_o. Then the average per-well rate q with additional injection wells is defined approximately by

$$\frac{q}{Q_o} = \left(\frac{P^2 - P^2_s}{P^2_o - P^2_s}\right)^{\frac{1}{2}} \qquad (10)$$

For instance, if the shutin pressure were 3700 psia and the injection rate were 20 million/day/well at 4400 psia, the average intake capacity at 4000 psia would be $20(2.31/5.67)^{1/2}$ or about 12.7 million/day/well. If there were three injection wells relative to 4400 psia, five wells would be required relative to 4000 psia. The cost of compressor service for 10 years would be reduced about $128,000 by operating at 4000 psi. As a rule, dry gas injected through five wells can displace more rich gas prior to breakthrough than the gas injected into three wells. So if two additional injection wells could be had for $150,000, cycling at 4000 with five wells would be likely to have an advantage over cycling at 4400 psia with three injection wells. One well off production represents one-third of the total injection rate relative to three wells and only one-fifth relative to five wells.

Table 14-1
Approximate Plant Investment and Operating Expense

PLANT	Operating Pressure	Extraction Efficiency	Economic Limit BPMM	Investment Dollars Per Million	Annual Operating Expense[3]
Cycling	1600–180	1.0	15	35,000	12
Noncycling	600–1000	1.0	8	20,000	10
Stabilizer	600– 800	$1-\frac{10}{BPMM}$	None	6,000	10
Compressor[1]	Variable			180 (25R—5)	15
Water[2]	1000–2000			1600–4000	70

[1] For compression ratios R > 2.
[2] At 400-1000 barrels of water per million feet of rich gas.
[3] Percent of investment.

REFERENCE

[1] Jones, Park J., Vol. II, Optimum Rate of Production, Reinhold Publishing Corp., New York, 1946.

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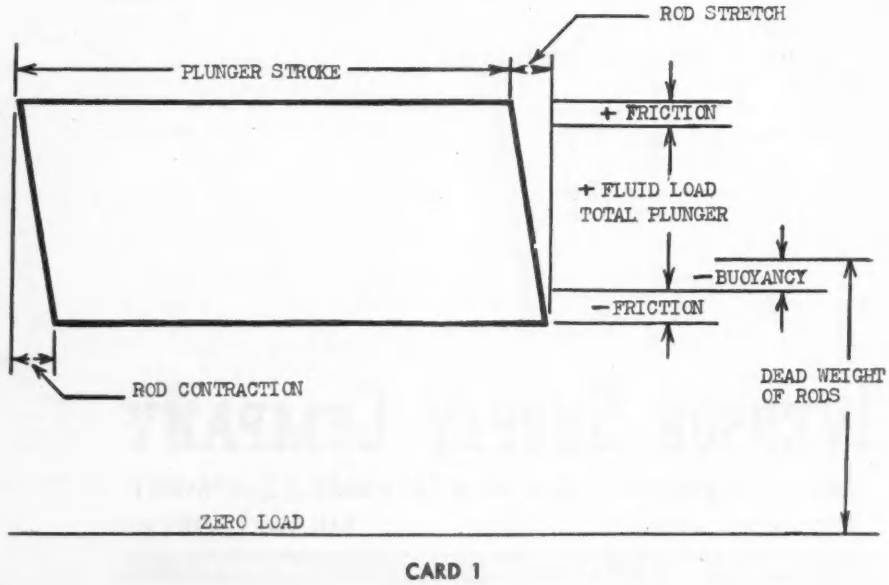
Practical Dynamometer Card Interpretation

By W. H. RITTERBUSCH, JR.
The S. M. Jones Company

THE end of World War II has brought a renewed interest in well-study work, primarily because of the increased cost of equipment and services. Many operators recognize the savings to be realized by an organized and planned well-study program, directed toward reduction of rod, pump, belt, beam and gear box failures with the subsequent reduction of downtime. In certain cases increases in production are possible by more efficient application of the well equipment itself.

Since there are many engineers and field men who are not entirely familiar with the operation of the various types of well-load recording instruments and the analysis of the results obtained, this article attempts to set out some typical examples of dynamometer cards without delving into the highly theoretical background involving theories of resonant vibrations and their effect on the actual card shape. As for the weighing mechanisms, the Kemler electrical strain gauge dynamometer and the Westinghouse mechanical dynagraph are the most commonly used instruments. Either machine has its advantages, and the choice of the instrument depends usually upon what type is available.

A dynamometer card is the graphic summation of all the forces acting on the polished rod throughout the pumping cycle. These forces include static rod load, static fluid load, dynamic rod and fluid load, buoyancy, fluid friction, rod to tubing friction, pump friction and vibration. Of all these forces, the rod vibration has more to do with the deviation of the dynamometer card from the ideal rectangle as shown in Card 1. This ideal card is never attained in practice as it assumes a 100 percent volumetric efficiency and the lack of any dynamic forces. However, to illustrate graphically the effect of the various component forces on the dynamometer card, it is most useful. Referring to Card 1, the dead weight of the rods is reduced by the buoyant effect of the fluid in the tubing. Assuming a specific gravity of 1.0 this weight reduction is equal to approximately one-eighth of the dead rod weight for a straight string. Using the dead load of the rods less buoyancy as a base, the fluid load must be added to give the total load in a frictionless system. In reality rod, pump and fluid friction exists on both the up and down strokes, adding to the load on the upstroke and decreasing the load on the downstroke. Rod stretch delays the transmission of the load pickup and this is shown by the inclination of the card.



CARD 1

Vibrational Effect

The important fact to remember about rod vibration is that it affects the ultimate shape of the card and that at certain depths and speeds, a particular shape is generally obtained. Other than recognizing that the vibrational effect is there, it is well to disregard this factor and examine the cards for any unusual or definite characteristics which may be interpreted in terms of some condition either good or bad in its effect on equipment.

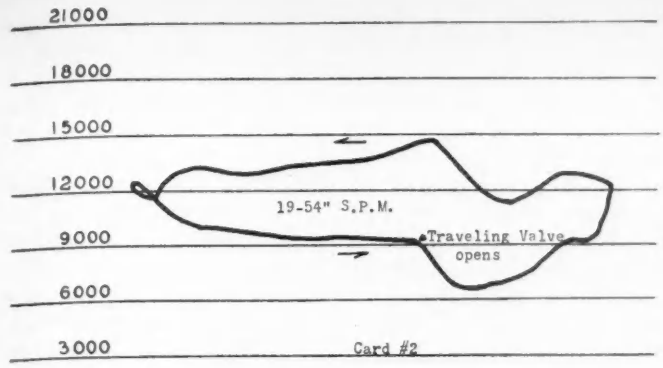
The first and probably the most important step in a well study is the gathering of all related data concerning the production, operation, equipment and mechanical failures. After this information has been compiled and a primary study has been made regarding calculated loads and volumetric efficiencies, it is then time to make the dynamometer test itself to obtain the additional information necessary to complete the study.

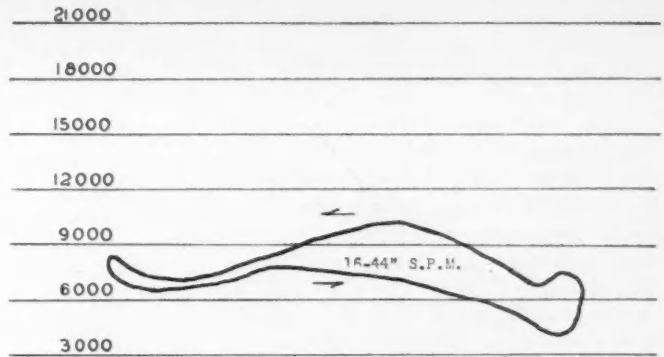
Of primary interest in a well study is the determination of factors which directly influence the service life of the equipment installed. From the dynamometer card we may easily determine the maximum load and range of load which affect sucker rod life, the torque on the gear box, the load on the beam, and the horsepower required at the polished rod.

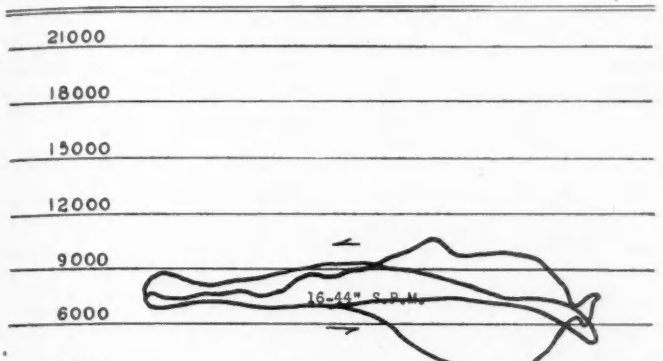
The peak load and range of load are taken directly from the card, and the torque may be determined by simple calculations using the formula:

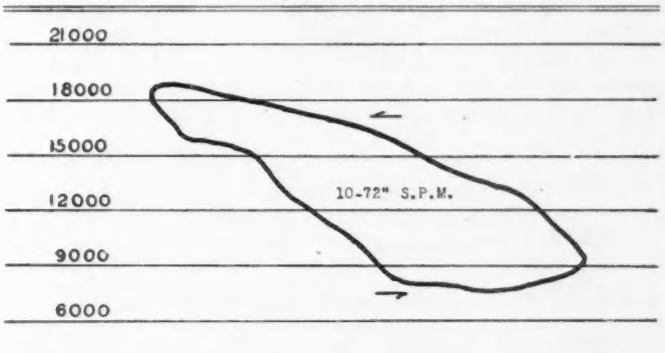
$$\text{Peak Torque} = (\text{Peak dynamometer load} - \text{effective C.B.}) \times \frac{\text{Stroke Length}}{2}$$

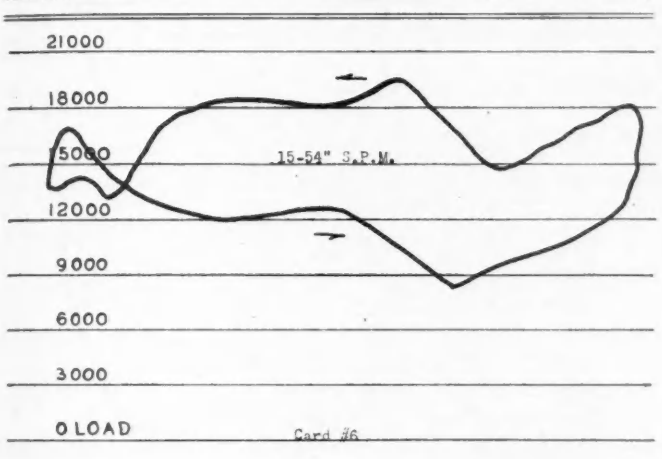
The polished rod horsepower is determined by measuring the area and length of the dynamometer card and

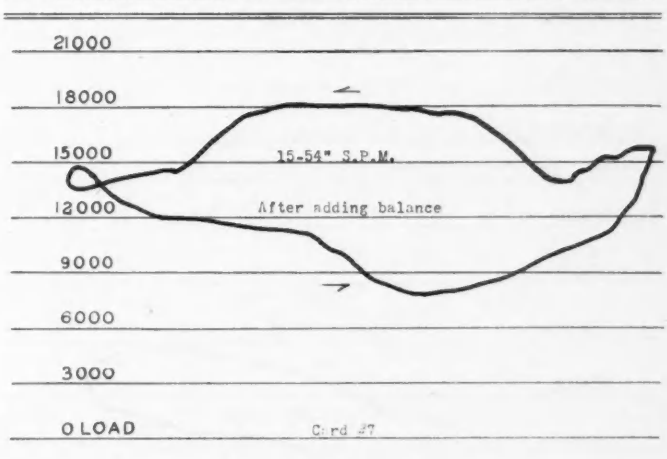












substituting the values in the formula:

$$\text{Pol. Rod H.P.} = \frac{A}{l} \times \frac{L \times N \times C}{33{,}000 \times 12}$$

Where A = Card Area (Square inch)
l = Card length (inches)
L = Length of stroke (inches)
N = Strokes per minute
C = Dynamometer scale constant #/in.

By dividing this figure by a percentage efficiency which may vary from 50-80 percent through the surface equipment, we have the approximate horsepower requirment on the prime mover.

Due to excessive pump displacement, a condition is often developed called a fluid pound. Disregarding corrosion, fluid pound probably causes more sucker rod failures than any other subsurface condition. The failures usually occur near the middle of the string or where the section changes such as in a tapered string, and often occur in the upsets of the rods. The action of the fluid pound is to cause an instantaneous shock loading on the rod string during the downstroke, which in turn tends to buckle the string at a time when the velocity of the beam is near its maximum.

Card 2 shows a typical fluid pound. Reduction in pump size or pumping speed is instrumental in reducing fluid pounds.

A gas-locked well is seen in Card 3; and Card 4 shows the gas lock being broken by closer spacing of the pump valves to obtain a higher compression ratio. Maintaining sufficient pump submergence so that the fluid entering the pump will be at a pressure well above its bubble point is very effective in reducing gas lock. A long stroke gives a higher compression ratio which also tends to prevent gas locking. Installation of an effective gas anchor will also do much toward increasing volumetric efficiency.

When too much pump displacement is used for the size of rods employed, a card similar to No. 5 is obtained. This shows an increasing load throughout the upstroke, indicating the rods are stretching and that a large part of the plunger travel is being lost in rod stretch.

Cards 6 and 7 show the effect of counterbalance changes on peak loads. This well load was reduced by moving the counterbalance weight out to the proper position as determined by the dynamometer cards.

Card 8 was taken on a well in which the rods had parted, and it was possible to calculate the approximate depth of

the part from the dynamometer card. This was done by dividing the measured load by the impulse factor and the weight per foot of the rods installed.

Some wells when put on the pump are nothing more than agitators, and the volumetric efficiency may vary from 15 to 100 percent, depending upon fluid levels, the gas-lift effect, and upon how much gas is brought out of solution by the agitating action. Cards 9 and 10 show agitation, and indicate the variance in efficiencies occasioned by fluid levels.

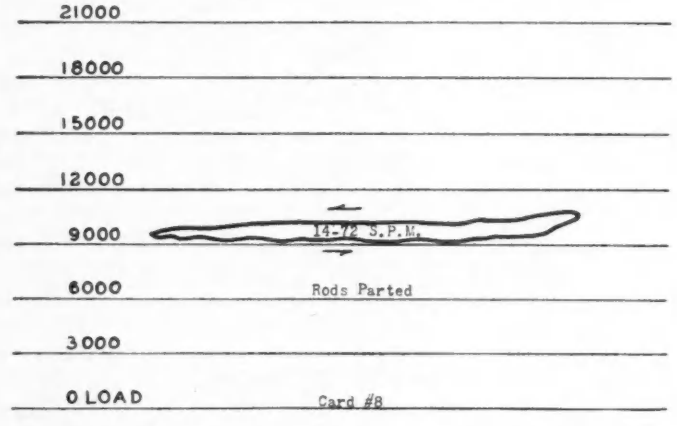
Plunger overtravel gives a card similar to No. 11 in extreme cases, and the motion approximates that of cable tool drilling. Abnormally high peak loads are encountered at the start of the upstroke due to the plunger and beam traveling in opposite directions.

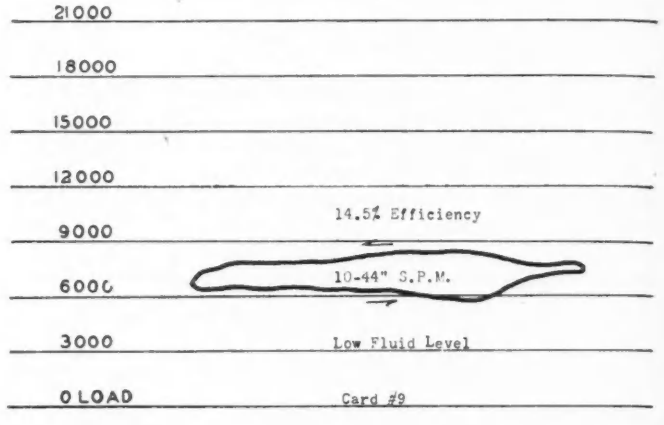
Effects of Harmonic Speeds

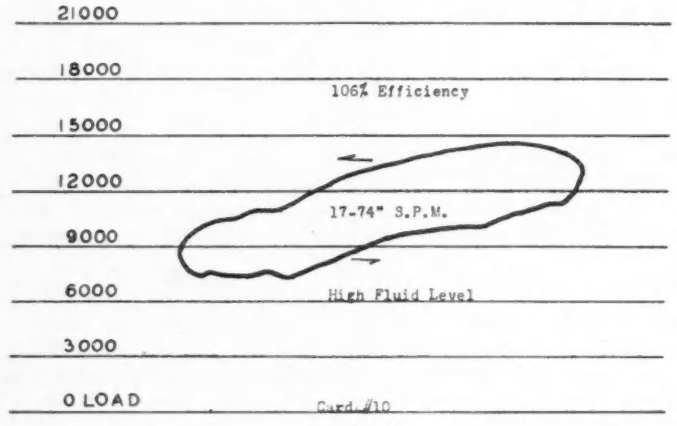
The effects of harmonic speeds are shown in Cards 12 and 13. In this case the peak load was reduced 1200 pounds by increasing the pumping speed from 14 to 17 strokes per minute. Generally, the effects of harmonic speeds are not apparent in surface dynamometer cards, and particularly where the well is handling a relatively dead fluid. This occurs because there are two impulses on each stroke as a result of the opening and closing of the traveling valve. In a gassy well, the gas compression on the downstroke does not lend itself to a well-defined impulse and therefore the only impulse recorded is that of the load pickup. This single impulse may become synchronous with the natural vibration of the rod string and cause a magnification of the load, whereas the two impulses in a dead well may be either out of phase with each other or the natural frequency of the rod string because of unequal time for the up and downstroke.

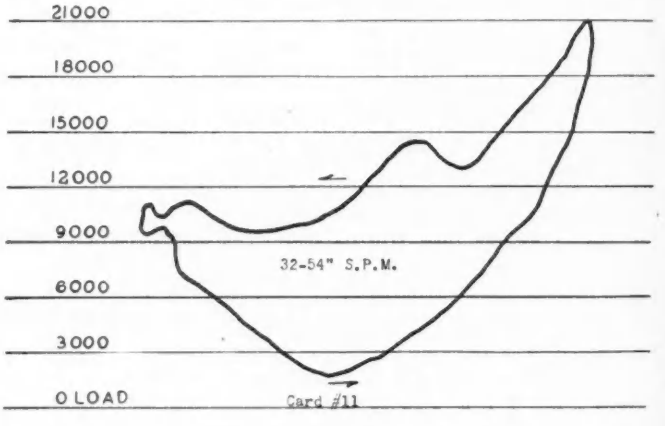
There are many abnormal shapes which a dynamometer card may assume, and only the most simple and commonly-occurring cards have been mentioned. Various investigations have done much to explain the many manifestations which the cards display, and yet the actual card interpretation is still rather an inexact science.

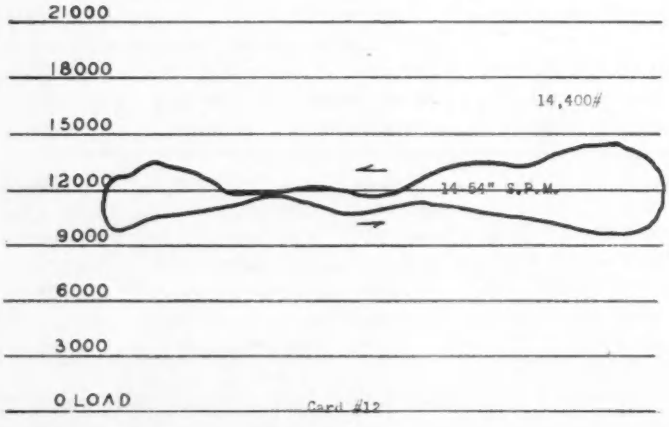
However, proper application of the dynamometer has and will continue to do much for the producer in reducing production costs and in furthering knowledge of pumping conditions.

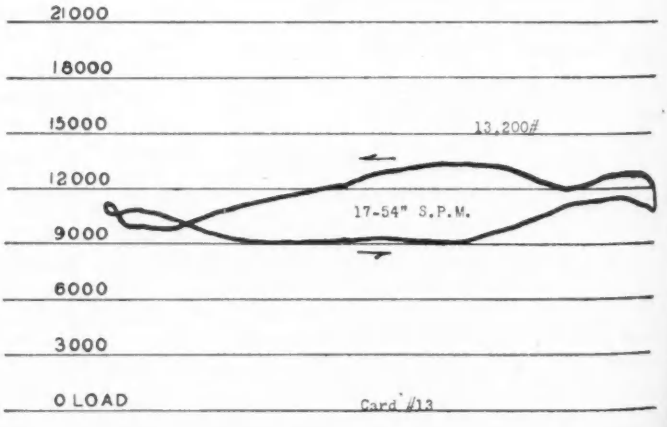


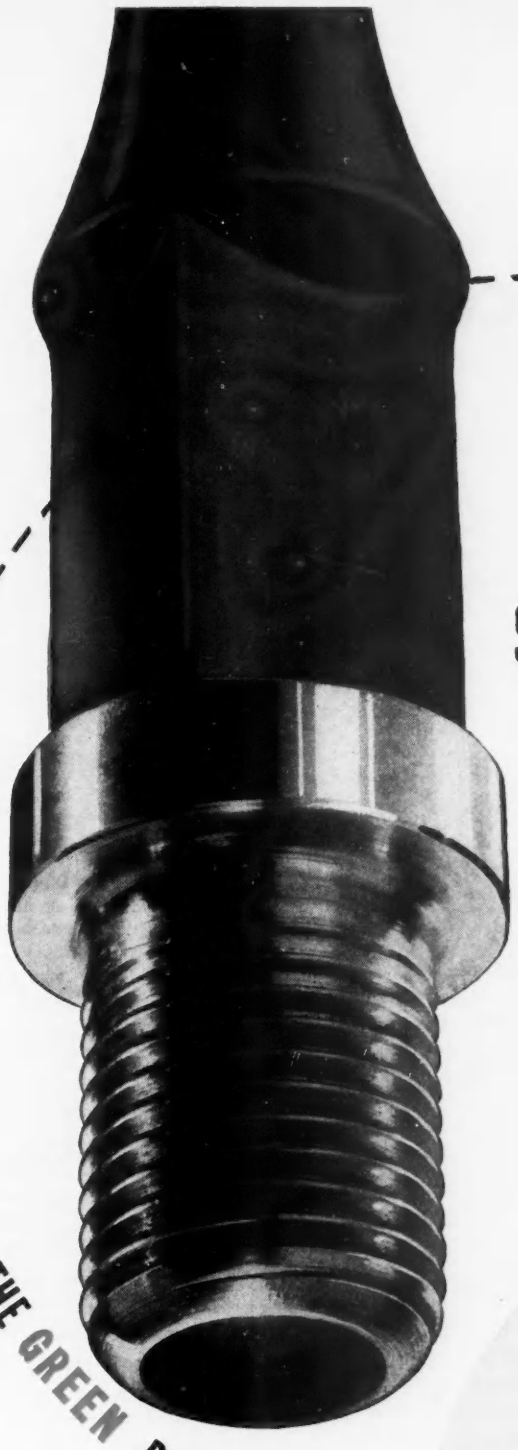


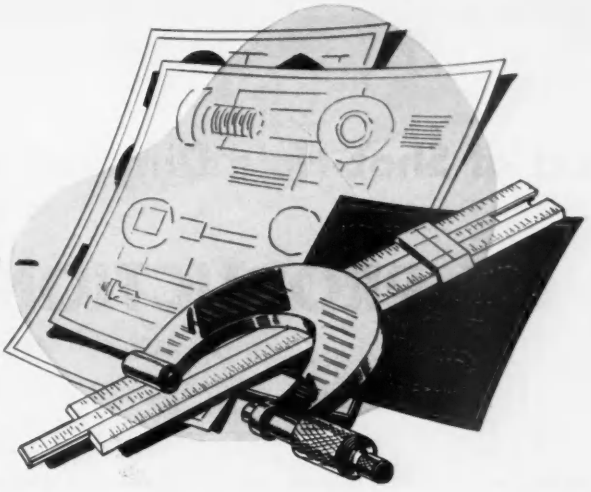












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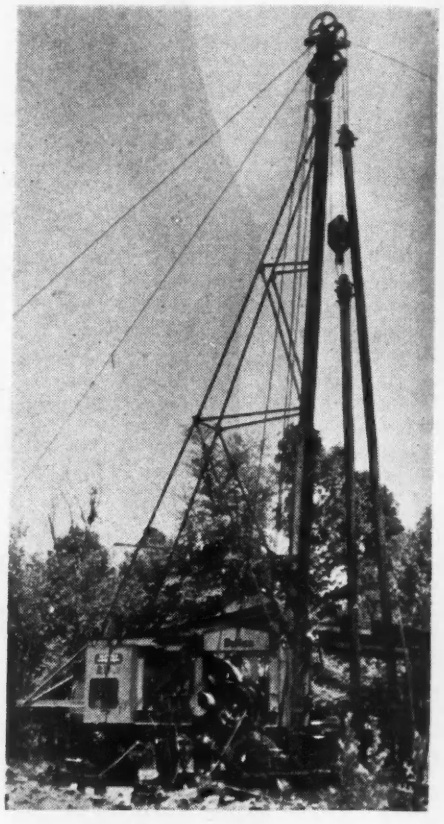
Effect of Shot-Hole Dimensions on OIL PRODUCTION COSTS

THE EFFECT of shot-hole size on the rate of production in thin sands can easily make the difference between a profitable well and one which does not pay out. The author discusses the manner in which shots may be regulated to equalize the effect on the sand and leave a fracture pattern with adequate collection volume without damaging the zone and risking cave-ins or slumping.

By F. R. COZZENS



Cleanout machine over well preparing for a shot which shows method of handling lubricators with sheave and wire lines.

THE shooting of newly-drilled wells is an oil-field practice having two basic objectives: first, to increase the volume of production; second, to increase the rate of production.

Assuming that the pay sand has a favorable oil content, and that the explosives have been rightly distributed through the various zones of the sand face, it seems logical to believe that both objectives are attained simultaneously when the blasting force creates the fracture-pattern, or the series of fissures which comprise the oil-gathering system leading to the well.

Unfortunately, this is not always true. Blasting force does establish the volume increase, but only partly determines the rate of flow. In most cases, some mechanical aid is necessary to complete the job. It is therefore possible to provide an adequate gathering system by an effective shot and still have faulty production because of some difficulty in the way the system functions. Various obstacles, entirely independent of the shooting procedure, can limit or restrict the flow of oil, and before passing judgment on a newly-shot well that fails to respond after a reasonable lapse of time, it is always advisable to check over the followup work and make sure that some important factor has not been neglected. Restricted oil flow is due sometimes to a too-hasty cleanout job; or, there may be insufficient driving force in the sand. More often, the trouble is located in the base of the well at that focal point of the blast-zone, commonly termed the shot-hole.

Although the shot-hole has little or nothing to do with the volume of production, it does very definitely affect the rate, especially as it involves the cost of getting oil from the sand to the tanks. Some shot-hole is necessary, therefore, in a producing well. Too much is a nuisance, and once its dimensions are established they can be enlarged from time to time, but never reduced. This fact should be kept in mind when a newly-drilled well is shot, and preparations made according to the need. Otherwise, a promising well can be ruined for future methods of oil recovery. Shot-hole requirements should be studied carefully before a well is drilled, and Eastern stripper field operators who have learned this lesson the hard way by trying out costly repairs on old wells damaged by pioneer methods of shooting are using a very different technique on new ones. The present procedure is to shoot a newly-drilled well twice—first, to establish the fracture-pattern; later, to form the shot-hole.

Planning Initial Shooting

Initial shooting, preparatory to later shot-hole expansion, is planned in advance so as to have the well bore made as large in diameter as possible through the pay sand. Wells started 12 to 14 inches in diameter at the top will generally take care of all necessary reducing points, and still permit the use of a six- to 6¼-inch bit (dressed fully out to gauge) through the pay. A sand bore of this diameter will readily accommodate a five-inch nitroglycerin shell for use in very tight and restricted sand-zones, and allow the use of smaller diameter shells in the loose and more porous zones. Regular drilling procedure is followed until the top of the pay sand is reached. At or very near that point the final bore reduction is made, and the inner string of casing is seated, either on a natural shoulder or upon a cemented bridge. The pay sand is generally drilled and logged by the foot; that is, short runs are made, and samples of the cuttings taken at each bail-out, so that the extent and texture of the various sand-zones can be determined. If a spudder is being used for the job the drilling line is flagged at one-foot intervals, and the spaces checked frequently with a measuring line.

Drilling is stopped immediately when the bottom of the pay is reached, and recorded measurements of the different zones usually are furnished to a local torpedo company with instructions to provide a shot that will equalize the sand column as nearly as possible. The order is filled according to the figures supplied, and since a shot is not believed to fracture a sand more than one foot

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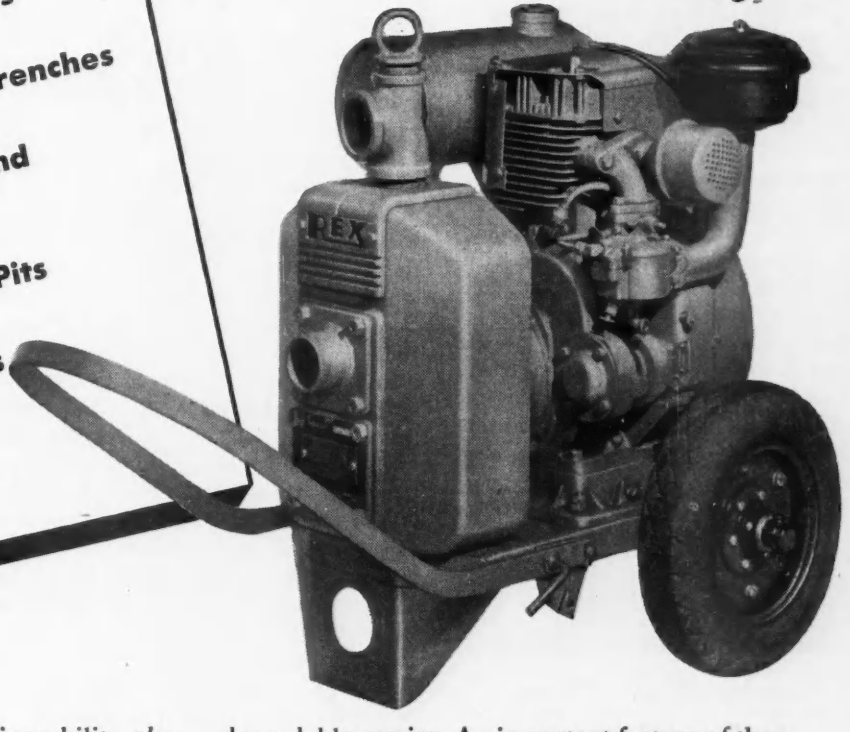

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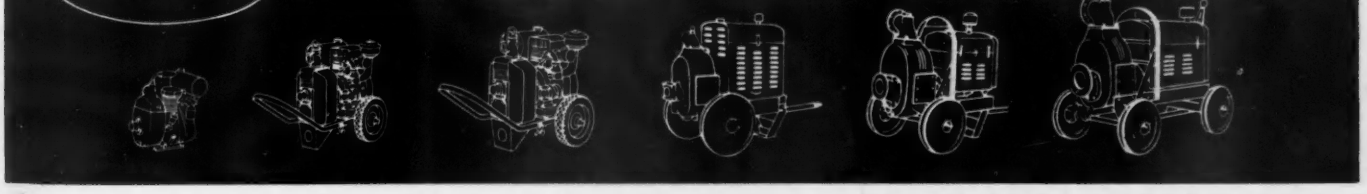

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above the top of a shell, nor farther than one foot below its base, measurements of all sand zones must be accurate and complete. A few operators believe it less expensive to select their own shots. In either case, the general rule is to give the tight and restricted zones as much straight nitroglycerin as the bore-space will allow. Three- and four-inch diameter shells are used through zones of ordinary texture, and very loose or open sand is seldom shot, the shells being replaced with spacers.

Water stemming is used over all nitroglycerin shots, since it is believed that a somewhat resilient stemming aids in obtaining a better fracture-pattern. Sufficient stemming is provided so that little or no spoil is thrown out of the hole, the usual recipe being one barrel of water for every ten quarts of nitroglycerin. An immediate cleanout is made as soon as possible after the shot is detonated, spoil and residue are stirred briefly with the drill, then bailed out.

The purpose of the initial shot thus distributed and stemmed was to create the fracture pattern, and generally adequate fracturing was accomplished without excessive shattering of the sand face. This means that little or no shot-hole has been provided. If the well is to serve only as an input, no further enlargement is needed at the moment, but a shot-hole area is measured off and charted for enlargement later, if, and when the need arises. One of the softer and more porous sand-zones, preferably three to six feet in length, is the usual preference for shot-hole location. On a prospective input, steel line measurements are also made to the top of each zone, so that packers can be seated for pressure induction.

Shot-Hole Enlargement

If the newly-shot well is to serve as a producer, as most of them are, it is promptly given a second shot, this time for shot-hole enlargement. The area of sand selected for the purpose is loaded with a slower acting explosive, usually gelatin or gelatin-dynamite, 60 to 80 percent strength; extra L. F. Six to eight pounds of a semi-solid explosive to each foot of sand is the general rule, and if regular cartridges in diameters to accommodate the bore can not be obtained, empty (unused) nitroglycerin shells will serve equally well as containers. An electric blasting cap (No. 8 or larger) must be taped into the pack, then connected to an insulated wire (copper) leading to the top of the hole and for some distance outside. All connections are insulated with waterproof tape, and firing is done by battery because the nature of the stemming makes it impossible to use fuse or squib. Stemming for the semi-solid explosives is generally finely-pulverized dry clay, sifted down slowly over the pack so as not to cut the line, or bridge the bore. Operators have no set rule as to amount. Usually, around 500 pounds of clay for an average size charge is sufficient, and to firm the stemming, approximately ten gallons of water are poured down on top of the mass. As a general rule, it is not necessary to lift, or remove the casing for this gelatin blast, and numerous operations have shown that even for the initial nitroglycerin blast, the top of a shell can be placed within two feet of a casing or packer shoulder without serious damage.

When a cleanout is made, following detonation of the gelatin pack, a much greater quantity of shattering will be encountered than was present after the first shot. Stirring and bailing of residue is necessary until the base of the sand column is open and free. After several wash-downs with salt water or an artificially made brine the well is bailed dry, and allowed to remain open for 36 to 48 hours. At the end of that period, the bailer again is run to bottom, and the sand line is flagged at the point where the bailer reaches the fluid level, at, or near the top of the sand column. Each bailer is measured out at the dump board until the well is bailed dry. If five or more barrels of fluid have been removed in the bailing process, an adequate shot-hole has been provided. If much less than five barrels of fluid are taken out, and the fluid level (at start of bailing) is in immediate vicinity of the sand-column top, shot-hole dimensions are considered inadequate for an effective pattern drainage, and a second, or a third charge of gelatin is required. Generally, however, one treatment is sufficient for a satisfactory job.

Any producing well thus treated can be used later as an input, since packers can still be seated above, and often below the shot-hole area, so that restricted zones can be pressured without the driving force coming in contact with the blasted area to cause excessive channeling. Other wells, previously prepared for inputs, or being used for either pressure induction or vacuum, can be changed quickly into producers by blasting out the shot-hole area which was formerly outlined and charted. Since no pockets or extensions were provided, any of these wells can be drilled down later to a deeper pay without rimming the bore, and the shot-hole drained into the lower sand through a perforated liner. It is also a simple matter to dewax or reclean the shot-hole cavity without interference with the lower pay by pulling the liner and closing off the bore immediately below its base with a temporary bridge of cement. After cleaning is finished, the bridge is drilled out, and the liner returned to its former position.

In a limited number of wells, it so happens that a good shot-hole and an adequate fracture pattern are both established by the initial blast. Sometimes, both objectives can be won simultaneously by combining two types of explosives in a single shooting operation. Such feats, however, are the exception rather than the rule in most districts, and the operator who attempts to duplicate them usually gets either an excessive shot-hole cavity and a poor fracture pattern; or an adequate pattern with a tight and restricted shot-hole. A clearly defined reason for this is yet to be learned. The complicated and intricate structure of a body of sand often makes it impossible to apply explosive force simultaneously for two respective purposes without one effort detracting some energy from the other. Type of stemming, and the way the stemming is used, also influences the fracturing and shattering power, as does the position of the explosives charge in its respective zones. Research workers are delving into this, and other shooting problems, and until more practical solutions are found, the average producer who operates on a very narrow margin of profit will confine his shooting technique to methods which are better understood and more easily controlled. Finally, he will back up the technique with determination to retain and improve upon the many benefits provided by explosive energy.

All practical benefits from a newly-shot well are provided through the fracture-pattern or gathering system which begins to function as soon as the charge is exploded. An adequate shot-hole terminates the system, and provides a normal outlet which stimulates fluid drainage through the entire pattern. By the same outlet, sediment and residue escape instead of accumulating in the fracture fissures. There is less "backing-up" in the sand of oil and water from the well bore, and because of it, one very treacherous form of Jamin action is eliminated. Besides stimulating the rate of production through the sand to the well, a good shot-hole helps speed production from the well to the tanks. By providing storage facilities, the well requires fewer pumpoff periods, and pumping can be done to coincide with other work on the project. At all pumpoff periods there is a full flow of fluid through the lines instead of a continuous dribble which usually is the case of wells provided only with a straight bore. This often makes it possible to operate low-production wells at a profit. The ultimate result in all cases is the recovery of more oil in less time, with substantial savings in the cost of labor, energy, and materials.

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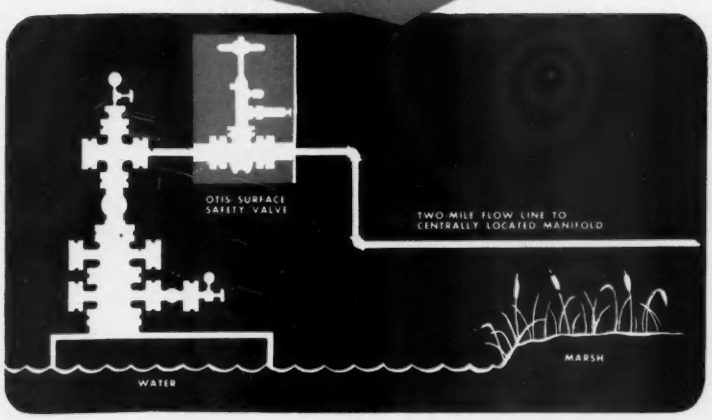
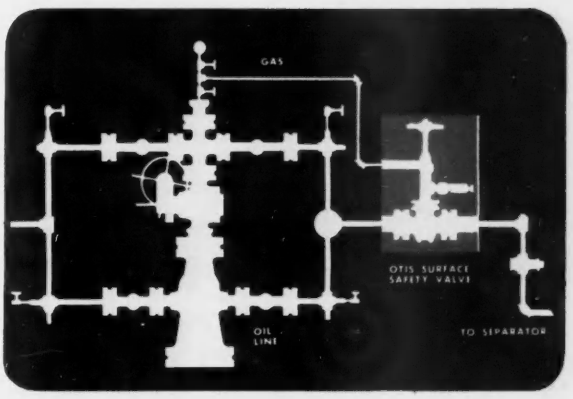
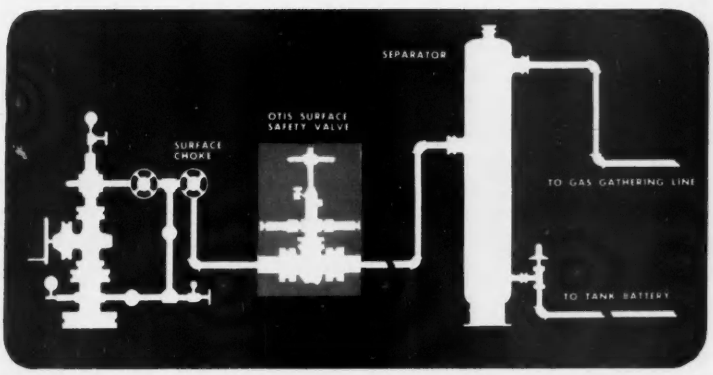


OTIS SURFACE SAFETY VALVE

TYPE WELL: Gas-distillate (highly-corrosive). **FLOWING PRESSURE:** 3700 p.s.i. **OPERATING CONDITIONS:** Well is located in a canal and is accessible only by boat. Flow line runs through marshy terrain to a centrally-located manifold approximately two miles away. Entire area is subject to seasonal storms and high water, while the canal carries heavy barge and boat traffic. If a line break should occur considerable time would be lost before the well could be reached and shut in. Furthermore, operating personnel would be in extreme danger if the break is located near the Xmas tree. **APPLICATION OF OTIS SURFACE SAFETY VALVE:** A Type XAB Otis Surface Safety Valve (a full-opening pressure-operated gate valve equipped with a low-pressure pilot) has been installed in the flow wing and is operated by pressure furnished from within the line. In case a line breaks and pressure drops below 3150 p.s.i. (that for which the Valve is set to close) the low-pressure pilot is actuated and causes the gate to automatically snap shut and remain closed until manually opened.



TYPE WELL: Dual-completion (gas and oil). **OPERATING CONDITIONS:** This well has been completed in a lower gas sand and an upper oil pay. Shut-in pressure of the gas formation is considerably higher than flowing pressure of the oil sand. The gas flow line is subject to freezing and the resulting high pressures build up beneath and threaten to unseat the packer, separating the two zones, if the oil zone which flows through the casing annulus is not immediately closed in. **APPLICATION OF OTIS SURFACE SAFETY VALVE:** A Type ZAD Otis Surface Safety Valve (equipped with a high-pressure pilot) is installed in the oil flow line, but is operated by pressure from the gas line. The pilot is set to close in the oil line when pressure on the gas line reaches 2150 p.s.i. This action allows sufficient pressure to build up above the packer and hold it in place against increased pressure of the lower gas zone.



TYPE WELL: Gas-distillate. **FLOWING PRESSURE:** 725 p.s.i. **OPERATING CONDITIONS:** This well is flowing into a separator, from which point gas is delivered to a gas gathering line which normally carries 600 p.s.i. The safety head in the separator ruptures at 765 p.s.i. During winter months freeze-ups in the gathering line cause pressure to increase to approximately 750-800 p.s.i. at the well head and separator. **APPLICATION OF OTIS SURFACE SAFETY VALVE:** A Type XBD Otis Surface Safety Valve (equipped with both a high-pressure and low-pressure pilot) has been installed in the flow line immediately downstream from the surface choke. The high-pressure pilot is set at 740 p.s.i. and will cause the Valve to automatically shut in the well when line pressure increases to that point, thus preventing dangerous high pressures from being placed on the separator. The low-pressure pilot is set at 450 p.s.i. and will also close the well in if a break or dangerous leak occurs in the flow line, or if the separator safety head ruptures.

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Cycling at *High Pressures* vs. Depletion and Cycling at *Low Pressures*

By E. O. BENNETT
Petroleum Consultant

THERE always has been a question in the minds of producers and operators whether to operate an oil field or a condensate recovery project under pressure maintenance at its initial pressure or to produce the field to partial depletion and then commence an injection program.

Cycling, as used by the industry, is a rather broad term and applies to both oil fields and gas condensate type fields. The condensate recovery from single phase reservoirs and the return of denuded gas is ordinarily termed "cycling." The production of oil and the return of included and accompanying gas is ordinarily termed "pressure maintenance." In principle, the operations are the same as reservoir fluids are produced, part of which are taken out, part burned as fuel, and the remainder returned to maintain reservoir pressure.

Before undertaking a discussion of when to start gas return, especially in condensate recovery operations, it appears advisable to enumerate the controlling factors involved in a field problem, whether it be in connection with gas return for pressure maintenance purposes in an oil producing property, or for the prevention of pressure decline in connection with a cycling project, for the recovery of hydrocarbon condensate.

The predominating consideration which controls is the one which will permit the greatest return to be made with the least capital invested, when operating under permissible rules of existing regulatory bodies or statutes.

It may be, and often is, possible to increase the ultimate recovery in barrels without regard to the cost of obtaining such recovery. Any such method is not one that will comply with the above condition and should not be adopted.

Price Factor

One problem that always bothers the producer or operator is that the price received for products has much to do with the method used for their recovery. A method of operation, or production, which will return the greatest earning with oil or condensate at one price may not do so at a different price. All have seen the price of oil vary from 10 cents to $3.50 per barrel, which is quite a range.

Although we do not anticipate any such variation of price range in the future, it can be readily seen that the best method of operating any pool or field would be to design for conditions at hand with as wide a range of flexibility as possible.

Methods of operation which always come up for discussion, in a new development, are pressure maintenance and cycling, by the return of produced, or produced and extraneous gas to the reservoir from which liquid hydrocarbons are recovered.

Pressure maintenance should, at no time, be looked upon as a "cure-all" for many of our producing ailments, and should be considered only where the profit made by its use is greater than can be realized by other methods of operation.

The general reasons for adoption of pressure maintenance operations are now well understood by the producing industry generally. Such operations are important to the natural gasoline phase of production, so I will briefly enumerate them once more as they are also important in cycling operations:

1. To retain sufficient energy in the reservoir to move oil to a well bore, from where it may be moved to the surface.

2. To maintain pressure to prevent gas originally dissolved in the oil from escaping, thereby increasing the viscosity of the oil and necessitating more energy to move a unit quantity through the reservoir.

3. To prevent edge or bottom water encroachment from moving the oil volume upwards into an otherwise oil-free gas cap, thereby reducing the amount of oil that may be recovered.

4. To permit oil to be produced at maximum rates, whereby the rate of return on capital invested will be increased and labor costs reduced.

5. To save a sometimes wasted supply of gas for subsequent use.

6. If pressure is not maintained, oil left in a reservoir will be "tank" oil. If pressure is maintained, oil left in the reservoir will have gas in solution and its "tank" oil content will be much less than that left by pressure decline production. Due to this fact alone, millions of barrels will be produced from large reservoirs by pressure maintenance that otherwise would be lost. This will also be the effect in an oil ring in connection with condensate recovery from a gas cap with oil at its flank edge.

It should next be pointed out that there are two types of subsurface reservoirs containing condensible hydrocarbons in the vapor phase. They are as follows:

1. A single phase gas reservoir where all liquefiable hydrocarbons are in the vapor state and no oil ring or column is present.

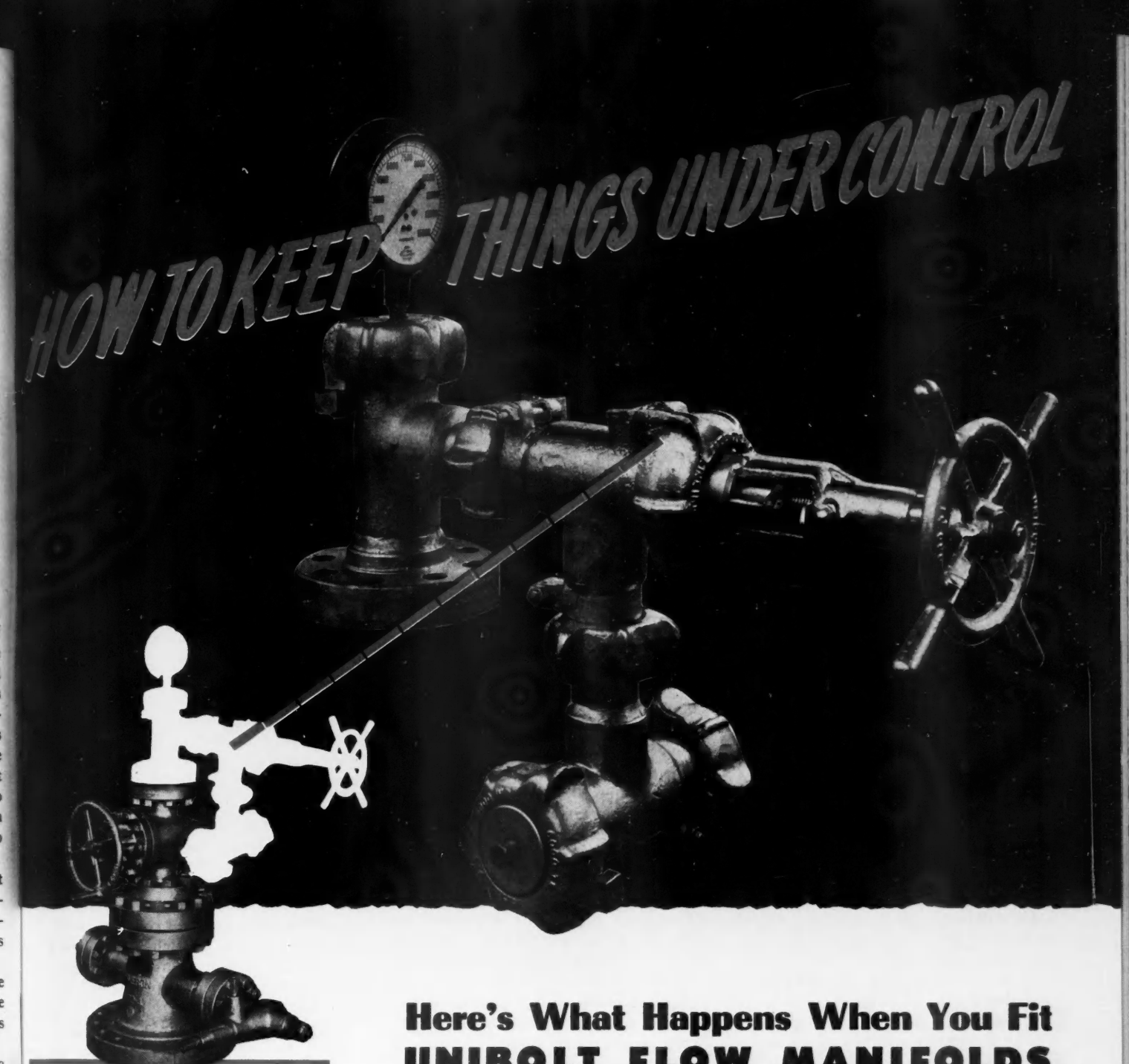
2. A gas cap reservoir containing a supply of gas and liquefiable hydrocarbons in a vapor state where such gas cap exists in connection with an oil ring or column.

Either or both of the above types of reservoirs may be and generally are accompanied by bottom or edge water or both.

As soon after discovery as possible, the size, and nature of a new pool should be determined, in order to evaluate the gas and oil volumetrically to ascertain their relatiev values and the method of operation for maximum ultimate economic recovery on capital invested.

Two-Phase Reservoir

If a two-phase reservoir is discovered, it is obvious that any method which will increase the recovery of liquefiable hydrocarbons from the gas cap, by causing a loss in recovery from the liquid phase, is wasteful and should not be conducted.



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Pressure decline methods of operation prior to cycling can and will cause serious losses where sizable oil volumes exist. This means that in a field or pool where such conditions exist in connection with a gas cap condensate section, pressure maintenance operations under high pressure cycling are mandatory, and until such time that the economic limit of oil production is reached there is no choice in the matter of operation.

Recently the methods of operating a single phase condensate pool have received much attention in an attempt to determine how to obtain the greatest economic yield.

In order to properly discuss this subject it is assumed that there is a market demand for all available gas and it need not be returned to the producing formation to save the gas itself.

Laboratory Work

A very interesting and enlightening discussion and analysis of the best method of operating a single phase reservoir was undertaken here on the coast by Standing, Linbad and Parsons, and presented before the AIME earlier this year.

Conclusions reached from this excellent laboratory study were "The recovery of the heavier components from a gas cap or retrograde pool under various production methods has been calculated. The results show that the recovery is greatest if the reservoir pressure is allowed to decline prior to cycling dry gas."[1]

The following discussions are assumed in connection with single-phase reservoirs only, although there are but few of this type discovered in condensate operations.

It also will be assumed that the proper type of unitization will be carried out as no condensate recovery project can be properly conducted in the absence of unitization. Concerning unitization, it is extremely difficult to understand the reluctance to unitization shown by some operators. No case is yet known where all participants have not benefited by unitized operations. This also will apply to two-phase reservoirs and no valid objections to unitization can be proposed, although many excuses are offered in each one that comes along. With a proper spirit of "give and take," and fairness among and between operators, there is no reason unitization cannot be made to work any place and under any conditions. Results from unit operations speak for themselves.

If a pool is to produce by pressure decline methods, liquids will condense out of the vapor when the critical pressure is reached. Such liquid will remain in the formation unless again vaporized and carried out by recycled dry gas. The reservoir temperature is assumed to remain constant under pressure decline operations.

Under pressure decline operation only a minimum of producing wells is required as no consideration of sweep pattern efficiency is involved. All gas will find its way to the wells used because of pressure differentials created. The laboratory work leading to the conclusion above stated indicates that the greatest recovery will be obtained by cycling three times the gas at low pressure. It is not believed that sufficient correlation exists between laboratory work and field practice to apply such conclusion directly. Some of the disturbing factors are pointed out below.

If the pressure in a reservoir was originally 4000 pounds per square inch absolute, as indicated for maximum recovery before cycling, approximately 90 percent of the original gas would have been produced, assuming no water drive exists, and that the gas follows Boyle's Law. Neither of which is quite true but will suffice for this discussion.

The number of wells required or permitted may be limited by the rules and regulations of regulatory commissions, or by physical capacity of a well to produce.

The number of wells required to produce a volume under the above conditions will be much smaller than the number required to effect an efficient sweep pattern at the lower pressures. For an efficient sweep pattern a large number of wells would have to be drilled. To reduce the pressure, as above cited, in a large reservoir might require 10, 15 or 20 years. The drilling of many new wells in a field at this time, with only 10 percent of the original gas in place in order to effect an efficient gas sweep, would hardly meet with management's approval, especially where the cost could run into $1 million or more. If a field was produced under pressure decline and management would not then drill the wells required, the field so operated would show much less recovery than one where cycling was involved at high pressure.

The experiments showed that for the test conditions 100 percent of the residual condensate could be vaporized after the gas had passed through the sand three times at pressures well below the retrograde point. Under actual field conditions it would be necessary to pass more than three volumes through the sand because of irregular advances through the sand body, and because of the nature of the sweep pattern.[2] It must be remembered that 100 percent vaporization also can be effected by recycling the stripped gas at pressures above the retrograde point at fewer than three volumes. In either the retrograde or normal region of pressures, recycling of stripped gas would cease when the produced gas became so lean that it could not be produced and reinjected profitably. In high pressure operations as now actually practiced, cycling continues until the economic limit of recovery is reached. In practice the relative efficiency in recovery of liquefiable products in the gas would depend upon the relative costs per Mcf and other economic and practical considerations.

Varying Conditions

Economic and practical conditions vary quite widely in gas condensate reservoirs, particularly with respect to the market for residual gas. Where there is no satisfactory market for the residue gas, economics will usually cause cycling at original pressures until a market can be developed. Where there is a satisfactory market for the residue, the deferment from the sale of rsidue gas must be balanced against higher and quicker recovery of condensate and the possible appreciation in gas prices while it is being withheld from the market. From the profit standpoint it is usually not profitable to build and operate a cycling plant when a satisfactory residue market exists, except for rich gas of at least 50 barrels per million cubic feet. Many gas reserves have oil rings which may be the compelling reason for withholding from an available market until the recoverable oil has been produced. Under such conditions it is likely to be profitable to cycle the gas cap to obtain income from the gas liquid contents, while recovering the oil. If such a pool is not unitized, the matter of correlative rights can offer serious handicaps to both the oil and gas cap operator.

From the standpoint of pure conservation, cycling is not justified except on the richer gases. The savings in liquid products must offset the greater field consumption of gas in a cycling plant and the break-even point has been found to be at about 50 barrels of liquid recovery per million cubic feet of gas. The loss of gas for fuel becomes a more predominant factor for recycling at lower pressures.

The total recovery by pressure maintenance or cycling at high pressure and that which may be recovered by pressure decline from initial pressure to a low pressure and then using a gas sweep should recognize all factors to make a proper comparison.

It is believed that the comparison should be by comparing the total liquids recoverable down to abandonment of the project in each case. In high-pressure cycling, part of the liquids will be recovered while the pressure is maintained, and an additional quantity will

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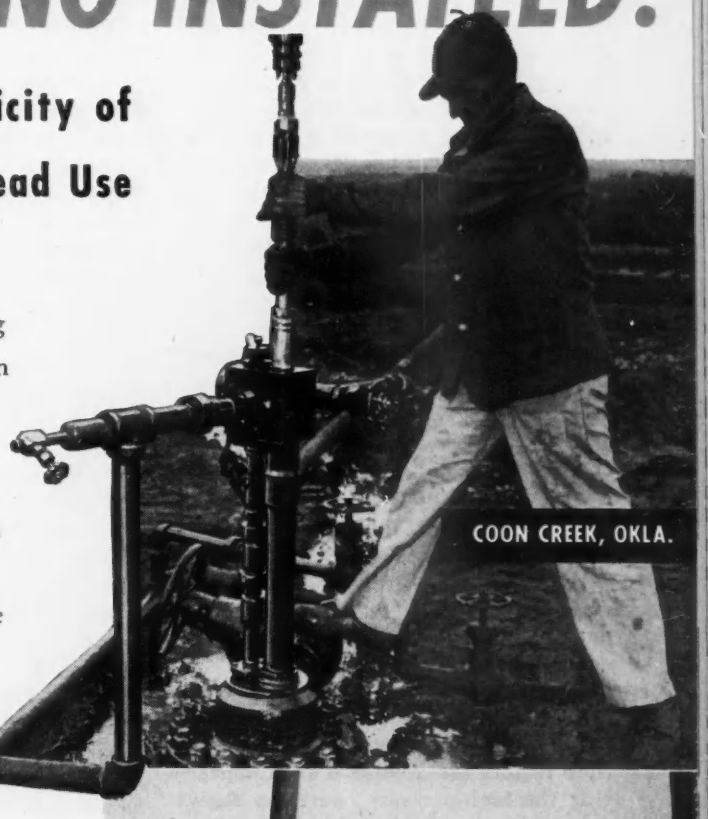
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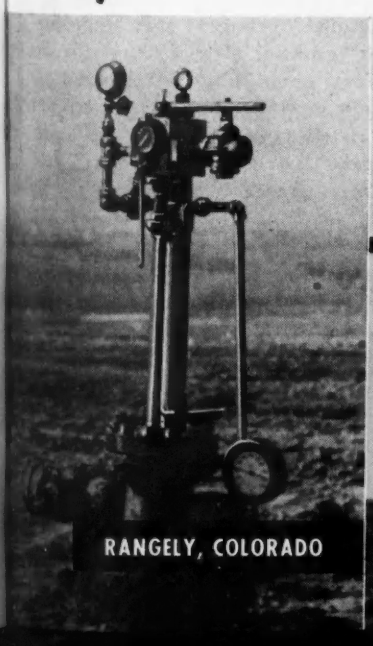
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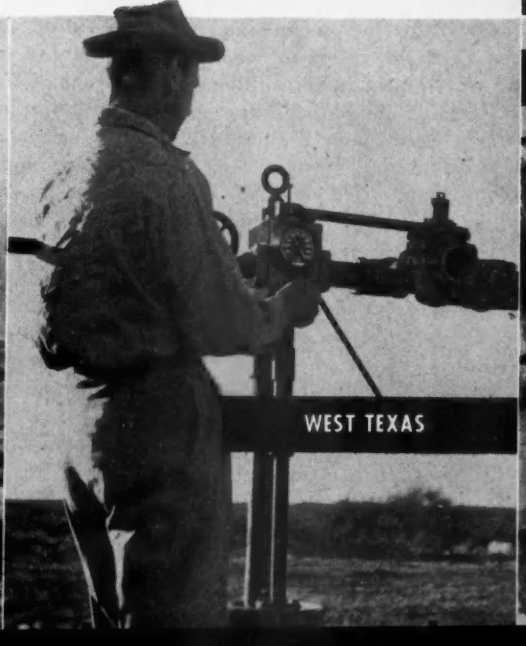
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be obtained during the period that the field is having its pressure depleted by the sale of the residual gas (after cycling at high pressure) down to the abandonment pressure. The volume of liquid which will remain after the high pressure cycling was shown by the experiments to be 29 percent; 58 percent of which would be recoverable during the depletion by sale of gas. The sum of the two values is 87.83 percent, which is greater than the 87 percent shown by the experiments for early pressure depletion and gas sweep.

The amount of liquid recovery that will actually be obtained from the time cycling is stopped under the high pressure program down to project abandonment period will be governed to a large extent by the content of the gas and the type of plant doing the processing. When the cost of processing is greater than the recovery value the extraction will cease in both methods of operation.

With credit to the high-pressure operation of the economically recoverable quantity of liquids to abandonment for comparison of the total quantity of liquids economically recoverable by the decline and sweep method there appears to be no choice. When drilling costs and time factors are applied it then appears that the high-pressure operation shows far greater recovery and is the system which should be used.

It is appreciated that a single specific example is not sufficiently broad in its application to justify any final conclusion, as the type of reservoir material can and does vary over extreme ranges between fields, and this fact alone will make some difference in conclusions reached.

Examples

Conservation and correlative rights do not always go together and some interpretations of conservation can cause confiscation. The following examples are given to show the practicality of cycling at high pressure vs. depletion and cycling at low pressure.

A reservoir containing 100 million Mcf of gas at 3000 psia pressure has five wells averaging 30,000 Mcf daily potential is assumed. One well is to be used as an injection well and four are to be used as producers. The sweep pattern efficiency is assumed 80 percent of the wet gas volue.

If cycling were applied to such a field, under original pressure conditions the average producing pressure during the cycling period would be about 2750 psia, and the average potential 26,000 Mcf. Assuming permissible production of 20 percent of the potential the production per well would be 5200 Mcf and the field production 20,800 Mcf daily. Allowing for a total dilution of the wet gas by dry gas in the amount of 20 percent, the reservoir would be cycled out in 13 years, after which gas sales would begin and be carried out continuously until the abandonment of the reservoir. During this production most of the remaining wet gas would be processed.

Next, assume the same reservoir had been depleted so that the pressure had dropped to 1000 psia before cycling was commenced. The gas reserve would then be 33,300,000 Mcf. During cycling starting at this pressure the average producing pressure would be about 800 psia and the average potential 3200 Mcf. Twenty percent of this potential will be 640 Mcf per well or 2540 Mcf for the field. At 80 percent producing efficiency in sweep pattern it would take 28½ years to pass one volume of gas through the reservoir sand and 85½ years to pass the gas through three times.

Now, assuming the pressure be permitted to drop to 500 psia before cycling is started, the reserves in the reservoir would then be about 16,700,000 Mcf and the average production pressure about 350 psia. The well potentials would be about 1100 Mcf and at 20 percent of this capacity the well production would be 220 Mcf and for the field 880 Mcf. It would take 41½ years to pass the gas through once and 124½ years to pass it through three times, assuming field efficiency equal to laboratory efficiency.

From the above it can be seen that if the decline method down to 400 or 500 pounds were used and then cycling commenced, that many more wells would be required to produce the field out in the same time as could be done under high-pressure cycling. The first case presented above would require 85/13 or 6½ times as many producing wells as originally existed, or 22 new wells. If the field was 10,000 feet deep the wells would cost $100,000 or more each, and a new investment of $2,200,000 would be required. If the liquid content initially averaged 60 barrels per million feet and, as the laboratory experiments indicated, 16 percent more liquid recovery could be realized by the decline and sweep method then the reservoir we have assumed would contain six million barrels of recoverable liquids and the gain of 16 percent would have been 960,000 barrels. At an assumed price of $2.15 per barrel or a net price of $1.95, the gain would be worth $1,870,000 and its cost $2,200,000, indicating that the operation would not be justified.

If the additional wells were not drilled the time required to earn the income from the 16 percent increased recovery would be more than offset by the discount factors which must be applied against the deferred income.

If we go to the 500-pound pressure it can be seen at a glance that the number of wells required to deplete the field under any reasonable period of time becomes prohibitive and cannot be considered at all because of the state of depletion of the reservoir.

From these cases it can be seen readily that high pressure cycling without depletion and gas sweep is more economical and that the increased recovery which might be made by decline in pressure and gas sweep methods will cost more than its market value, and is not in the realm of economical range of recovery.

To cycle at low pressures the cycling plant would be smaller and less costly, but the expense of producing, processing and reinjecting the gas would be considerably more per Mcf, hence it could not be produced to as low a content as under high pressure cycling.

The gas content at 1000 psia would be much less than the original, and at 500 psia it would be nearly as rich as at the original conditions. At lower pressures it would become even richer, as has been shown by Lewis.[8] To start cycling then would be to prevent the gas from becoming richer, whereas cycling in the early stage of operations would prevent the gas from becoming leaner. The ultimate quantity of liquids will, however, be theoretically increased by low pressure cycling, but such theoretical increase cannot, in the light of present practice, be done except at a loss.

During the time the field pressure might be depleted under pressure decline methods, gas sales would in all probability take place and gasoline and pipe line facilities installed, markets established and sales contracts made. When the lower pressure was reached the operator would be confronted with the alternative of taking his residue gas off the market, installing an injection plant and the drilling of more wells or withholding his gas, not for 13 years in the case of high pressure injeection, but for many times the 13 years. It is not hard to visualize most operators deciding against cycling at this stage under such conditions, or if they did go ahead, they could not be expected to operate cycling long enough to approach the completeness of revaporization, indicated by the laboratory experiments, and needed to increase the recovery.

The above examples of a field case assumed a sand body of moderate thickness and permeability. If instead of the potentials used, the well potentials were three times as large, cycling at all three pressures discussed could be conducted in one-third of the time stated. In fields where wells have high permissible allowables the disadvantage of delayed cycling would not be as great as with

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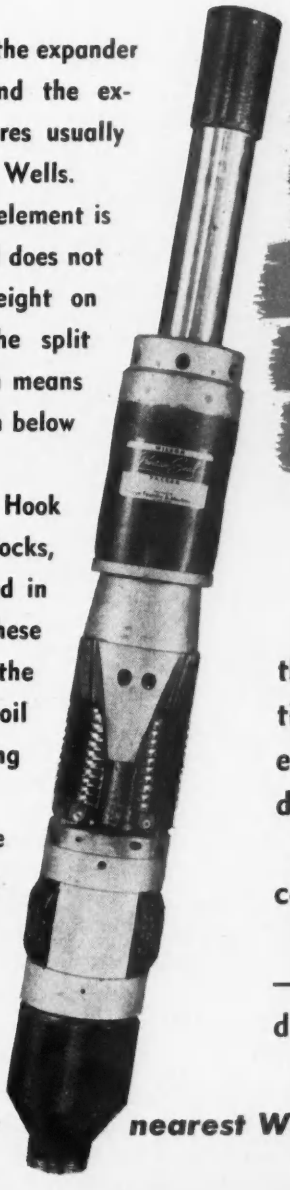

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smaller wells, but economic considerations would cause cycling to cease when the content of the gas became worth less than the operating expense, and there would still be the disinclination of the operator from severing his gas markets and current income.

Since reservoirs which are initially under retrograde pressures are always deep, they cannot be profitably produced to very low pressures, except where the sands are very permeable and quite thick, and where the price of gas is high. In some deep fields, the prospects are that it will become uneconomic to produce them much below 500 psia.

An intensive study of the effect of reservoir temperature on retrograde loss indicates that as the reservoir temperature increases there is a decrease in the loss resulting from retrograde condensation.[3] From this it may be anticipated that the retrograde losses from deep reservoirs will be less than for the shallow ones.

Under the above conditions, aside from the economical considerations previously discussed, the use of revaporative sweep along with pressure decline will become less effective with regards to total recovery as deeper development is encountered, and since all indications point to condensate recovery in many real deep pools, the pressure decline and gas sweep method appears to have but little value for future operations.

In the laboratory work where it was indicated that the pressure decline and gas sweep method of operation would show the highest recovery, one important variable was not present. It was the permeability of the producing section which has so much to do with the sweep pattern efficiency in a field operation.

If wells are properly spaced and injection rates controlled it is possible to have a high sweep pattern efficiency under pressure maintenance or early cycling.

Permeability does not follow regular and stratified patterns and flow in an actual operation is not always lateral. Diagonal flow often exists. Many hundreds of core samples have been recently analyzed in a large new cycling program in North Louisiana and the permeability followed no regular pattern.

If lenticular islands exist in a large sand body, and tests indicate this to exist, it can be seen that as long as pressure is maintained above the retrograde point the gas in these "islands" can move to the producing wells. If, on the other hand, the pressure is reduced below the retrograde, the liquid condensing in the island area occupies a much larger percentage of the total hydrocarbon pore space than in the more permeable zones and an effective block to any material flow is caused, which will result in the bypassing around these "islands" during the gas sweep in the pressure depletion operation. This will reduce the recovery and it is not believed that the laboratory conditions can be reached or even closely approached.

Experience indicates that reservoirs less than 4000 feet deep show no important retrograde characteristics and that the capacity of wells to produce generally increase with depth. The liquid volume is generally greater in the deeper wells.

As the condensate wells go deeper the problems of operating them at 400 psia or less become very critical, and a safe limit for production operations alone will prevent getting down to the suggested pressures.

Since the capacity of a gas to carry liquid in vapor form depends upon the total composition and distribution of such composition, it can be seen that there can be wide variation of the content of condensable hydrocarbons in gas that exists at the same temperature and pressure. Olds, Sage and Lacy[4] have shown how the capacity to hold the less volatile hydrocarbons in the vapor phase can be reduced by removal of propanes and butanes from the gas.

Effect of Pressure Decline Production on Gasoline Plant Operation

A gasoline plant can only be installed when:

1. There is a sufficient volume of gas for processing that capital invested, plus a reasonable earning can be made during the life of the project. More efficiency in recovery can be maintained with high pressure absorption. Under cycling and pressure maintenance the pressure will remain in a narrow band at a high level, and a high-pressure plant may be installed. Under pressure decline procedure a plant to take care of excessive conditions will operate with lower efficiency during the latter life of the project.

The horsepower required for returning gas under high pressure cycling will be less than under pressure decline and low pressure cycling as larger volumes of dry low pressure gas will be required for the so called "evaporative sweep." The content of much of the gas under pressure decline and evaporative sweep will be too low for economical processing and because of the volume required and the time required, the labor costs may become prohibitive. The time required to deplete the life of a condensate field would be far in excess of that generally considered available for equipment in a gasoline recovery plant.

Conclusions

1. Laboratory experimental work, while theoretically correct for the equipment used, does not adequately correlate test equipment with full scale operations in a cycling program, and conclusions reached by such work must be considered with extreme caution before being applied to actual production practice. All factors must be given consideration before proper comparisons can be made.

2. Theoretical differences in recovery of a high pressure cycling system versus pressure depletion and low pressure cycling do not show sufficient increase to offset the unknown and variable factors, to assure that pressure depletion and evaporation sweep will show any increased recovery. Where economics and time factors are used the reverse appears to be the result.

3. If suitable gas markets are available, a study should be made to determine whether or not the starting of a condensate recovery project will be economical where the reservoir gas contains under 50 barrels per million cubic feet of gas.

4. In the absence of a gas market at a reasonable price, cycling may be used in a field where the barrels of recovery are less than 50 per million cubic feet, in order to provide current income. Such an operation may not be the most economical if a market is later obtained but does permit current income prior to market availability.

5. A study of several existing cycling projects indicates that high-pressure cycling is more economical than pressure depletion and gas sweep would have been for the same fields and based on information and experience available it is the author's opinion that the present systems of condensate recovery in general use should be continued until more experimental data is available and the correlation of such data, when recognizing such factors, indicates changes should be made.

6. Conservation as generally understood in the oil industry is the elimination of physical waste, and since neither of the methods of operation discussed in this paper create waste, both will comply with all the conservation regulations generally in effect. Operations for conservation alone are not necessarily practical or economical, and when practical and economical considerations are applied to cycling operations, it will be seen that high-pressure cycling rather than depletion and evaporative sweep will predominate.

REFERENCES

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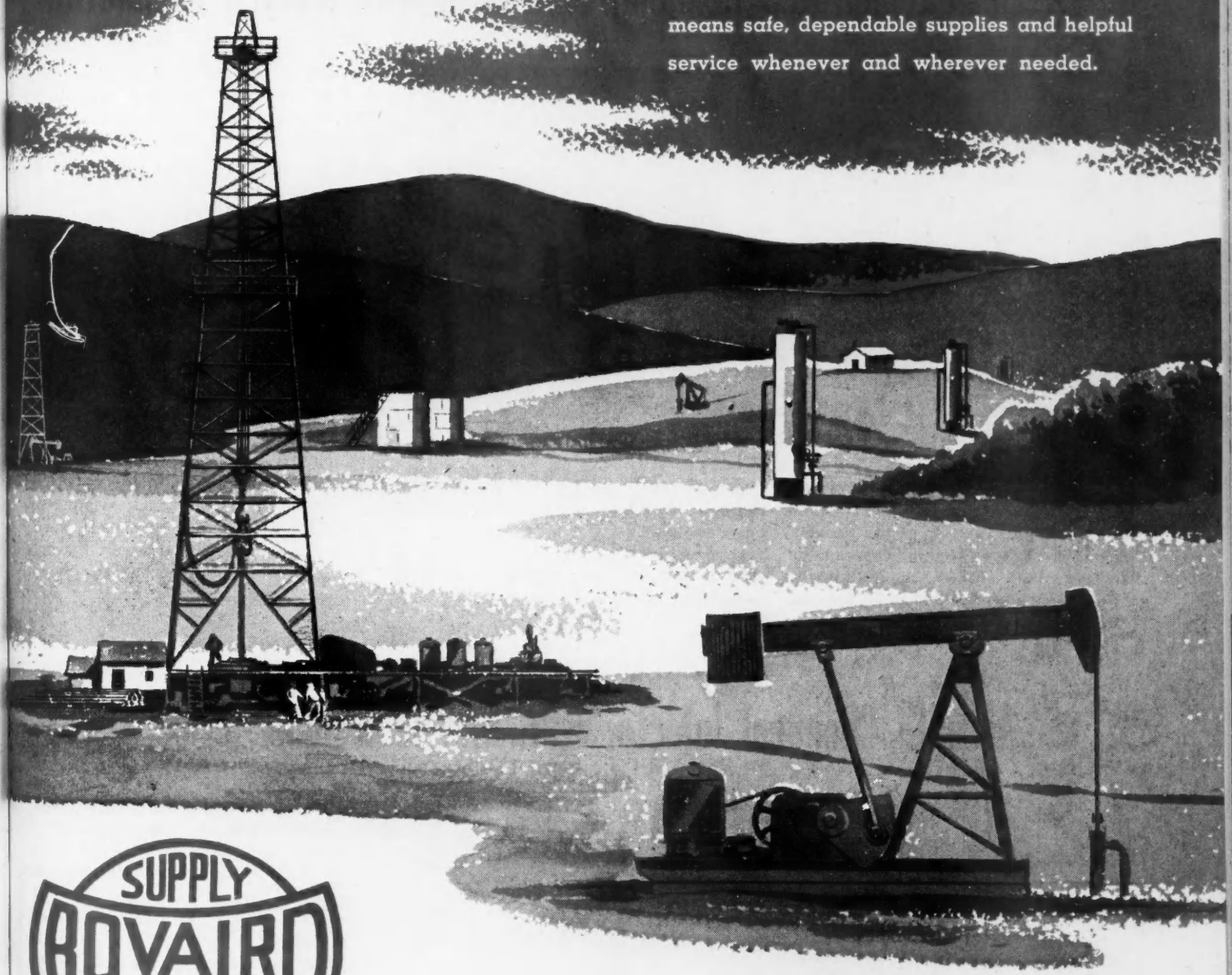

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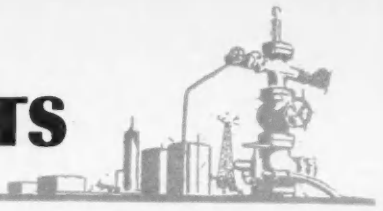

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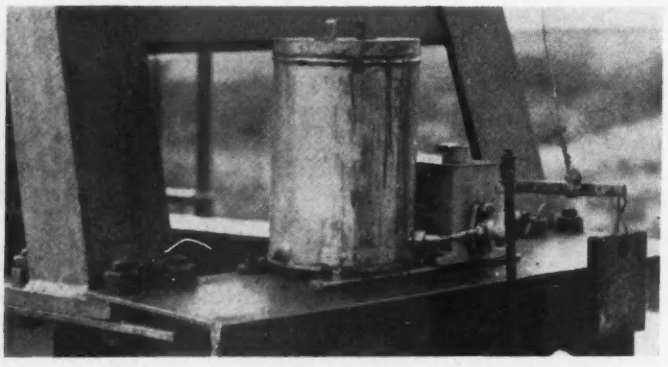
How To—Design Improved Pumping Unit Base with Slotted Foundation

An inexpensive method of anchoring the pumping unit to its foundation is contained in the installation shown. Instead of employing studs embedded in the concrete at various points around the unit, a shallow trough was cast in the base. This trough, approximately a foot wide, has embedded in its bottom several large eye-bolts, the eyes being of sufficient diameter to permit slipping a length of four- or five-inch pipe through them. One end of this horizontally-laid pipe is visible in the photograph. At several points along the upper side of this pipe, slots or holes are cut to permit insertion of vertical anchor bolts which are extended up through short transverse pieces of pipe laid across the upper surfaces of the I-beam base members of the pumping unit.

The pumping unit is rested on 2x12 planks laid immediately beside and parallel to the trough. After it is spotted, all that is necessary is to tighten down nuts on the several vertical anchor bolts. This type installation is particularly desirable when it is apparent that the pumping equipment may have to be changed at frequent intervals. It is readily adaptable to nearly any type pumping unit base. Still another advantage lies in the ability to move the unit in on rollers without the vexing problem of having to work over and around studs that often are set in the concrete mat. Laid out when the mat is poured, the trough type base is accurately lined up with the well head, thus eliminating much adjusting and squaring-up when the unit is installed at the well.

How To—Actuate Chemical Injector with Simple Weight Device



Many chemical lubricators or injectors require reciprocal motion to actuate the proportioning and pumping elements that push the chemical into the flow line. Various means have been employed to accomplish this action, and the method illustrated is another way of performing the job in a positive manner.

The reciprocating arm of the lubricator is perforated so that the amount of chemical injected into the flow line could easily be adjusted by merely altering the length of this arm. In the case shown, no stiff rods are required, but the actuating arm is attached to the walking beam of the pumping unit by a piece of galvanized wire. To keep the wire tight, and to also cause the arm to drop down with the downward motion of the walking beam, a piece of heavy steel plate was tied to the outer end of the actuating arm. In operation, a small amount of chemical was injected into the flow line with each stroke of the pumping unit. As the walking beam head went up, the arm of the lubricator rose, and as the beam came down, the weight on the arm brought it down to follow the walking beam.

Mounting of the lubricator was simplified by using a piece of channel iron, and cutting off one of the short legs. The plate was then drilled so that holes matched those of the pumping unit A-frame. The lubricator was bolted to this plate which provided a sturdy shelf on which to anchor the chemical feeding mechanism.

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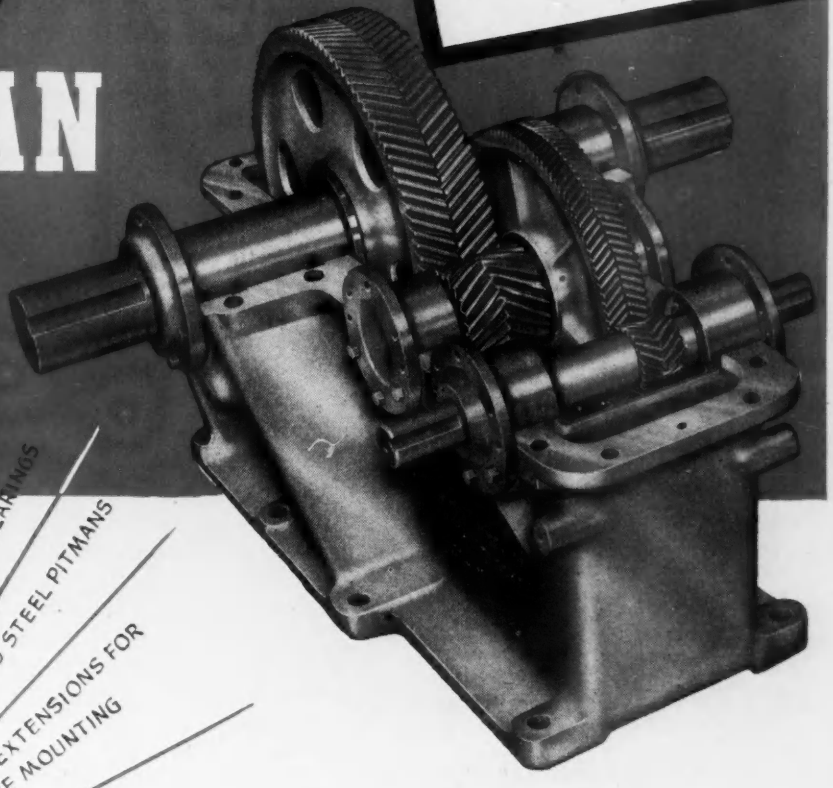

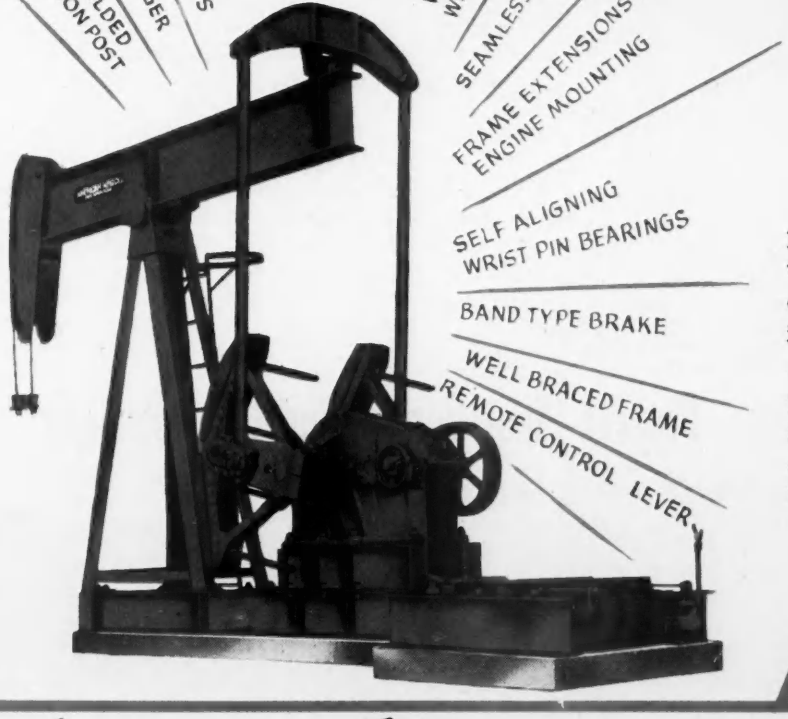

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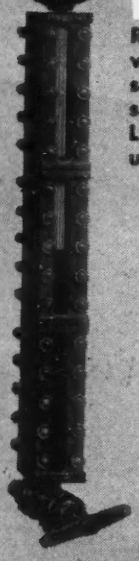

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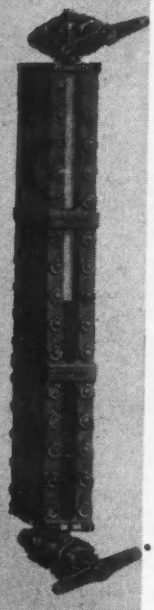

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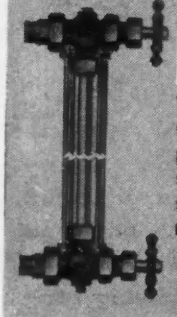

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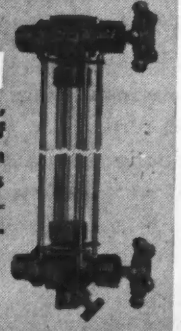
Tubular glass type, Chrome-Moly temperature resisting steel body, stainless steel trim, regrinding removable seats.



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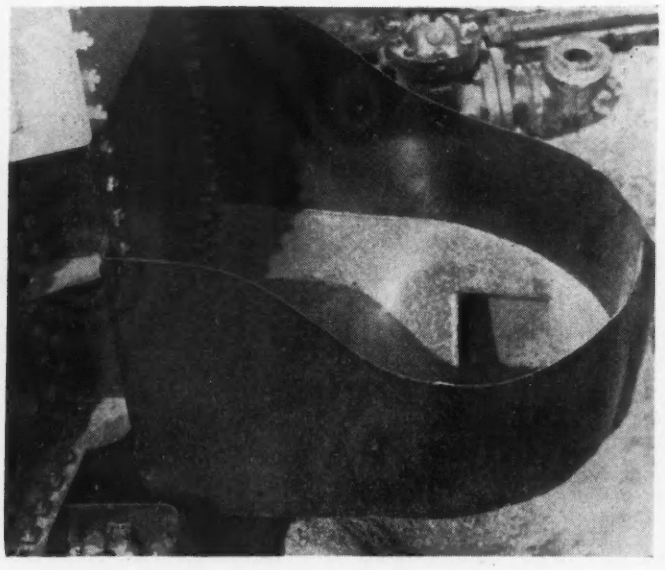
PRODUCTION HINTS

How To— Facilitate Cleaning Tank Bottoms

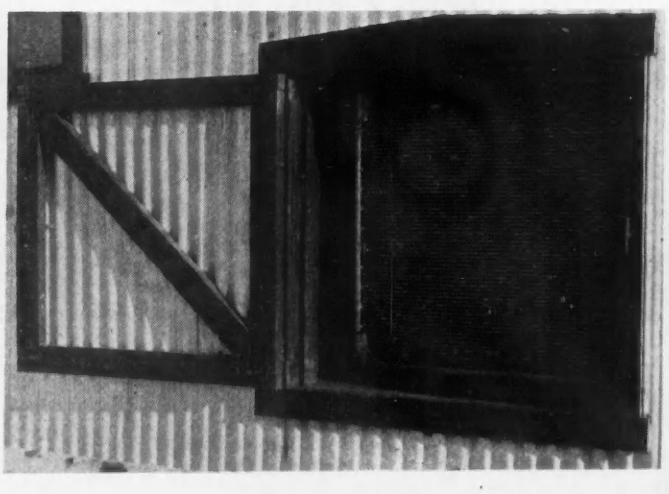


Depending upon the character of crude produced in a field, the lease stock tanks must be cleaned at various intervals to remove the sludge from their bottoms so an accurate check may be maintained on the amount of oil pumped into the pipe lines. In some areas this job must be done more frequently than in others, but it is one task that must be performed sooner or later on all lease stock tanks. Needless to state it is a messy job and one which few roustabout crews care to undertake.

The normal procedure is to permit the BS&W contained in the bottom of the tank to flow freely over the ground inside the battery fire wall. The device illustrated was designed by one gang pusher who made the job less difficult and left the inside of the lease battery wall as clean as it was found originally prior to the tank cleanout job.

A shallow concrete ditch was constructed to lead from the tank cleanout plate to the waste oil sump at the battery. The tank drain funnel was bolted permanently to the tank to receive the BS&W as it flowed from the tank during the cleanout operation. The funnel prevented the sludge from splashing and spreading over the ground around the cleanout plate. Eight-inch sheet iron was used and was welded together in the shape shown. A rectangular hole was cut in the bottom of the funnel to provide an outlet for the sludge directly into the ditch leading to the sump. The device can be bolted or tack-welded to the tank so that it will not interfere with removing the cleanout cover plate. Cleanliness of the battery was improved considerably thereby reducing a potential fire hazard.

How To— Protect Plant During Shut-Down Periods



In fields subject to shut-down proration, pumping equipment often is idle for days at a time, a condition which leads to equipment deterioration and making necessary additional upkeep. In one such field in West Texas, an operator provides a means of closing up the building which houses the central power plant.

Since no part of the equipment, except the

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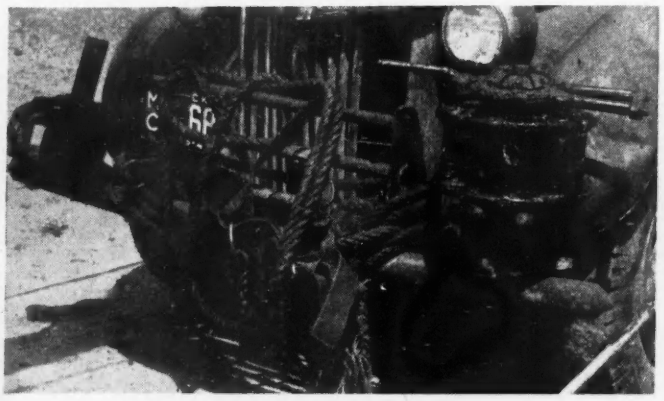
engine radiator, had to be exposed to the outside while operating, provision was made for this unit to be situated adjacent to one wall of the building. A rectangular opening was cut in the building, framed, and fitted with a side-opening door which can be swung open from the outside. When the plant is running, this door is allowed to remain open, but when it is shut down, the door is closed to protect equipment from weather, particularly rain and dust.

The engine radiator is mounted close enough to the opening that it would be impossible for vandals to gain entrance at that point, making it unnecessary even to lock the small door. The door was located on the north side of the building an important consideration, particularly in summertime, which eliminates much of the tendency of the engine to over-heat as it would if located on the sunny side of the building.

How To—Simplify Carrying Tubing Elevators



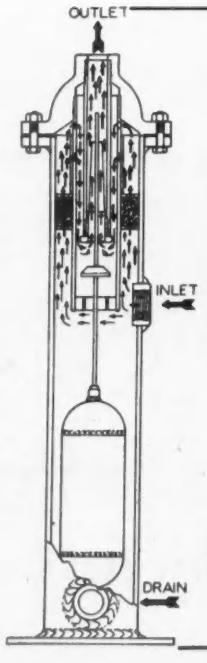
In order to provide additional space on their pulling unit truck, one service company operating in West Texas found it advantageous to weld an upright length of two-inch pipe on each end of truck's front bumper. On these pins are carried tubing elevators, spiders and any other tool of similar shape which has sufficient weight to hold it in that position.

Not only are they carried safely in this manner for ordinary travel on oil-field roads, but they are more readily accessible on the job and release space on the truck bed for larger and heavier tools. On the installation shown, considerable weight is on the bumper, but with some additional bracing and strengthening of the outer ends of the member, tools may be carried without difficulty.

How To—Make Positive Gate Lock

There are probably as many types of gate locks as there are welders who have to devise them. However, a device less simple and fool-proof than the one designed by one welder would be difficult to find. The lock consists merely of a single L-shaped bolt which is run through both the fence post and the gate member. As may be seen in the photograph, the bolt is fitted with a small tee handle to which is welded a short piece of flat steel. A similar piece is welded to the short nipple or guide that is welded to the gate post.

A lock may be run through holes drilled through these matching pieces. To lock the gate, the L-shaped bolt is



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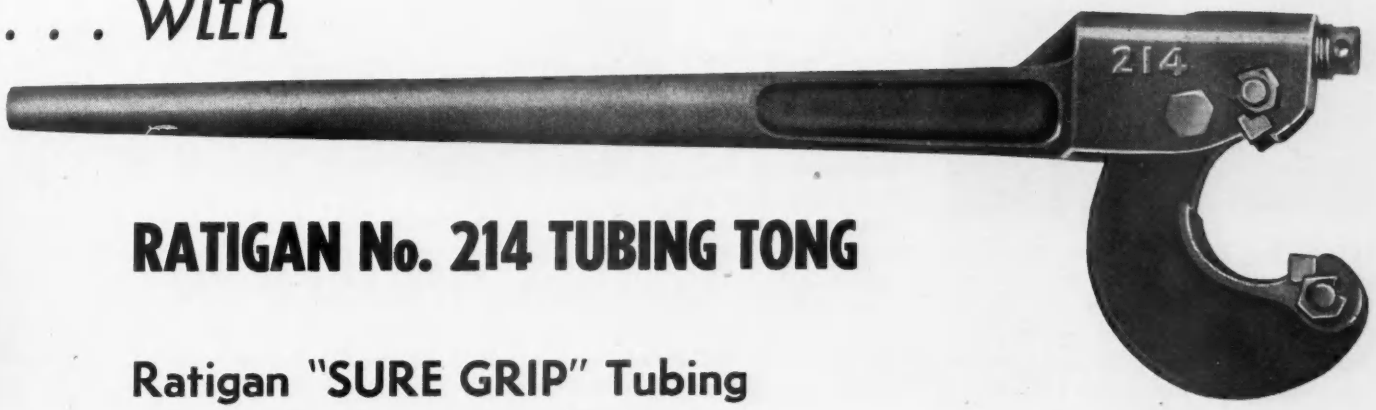

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The Ratigan No. 214 Tubing Tong is new in design and considerably lighter in weight than previous Ratigan Tongs, yet much stronger. It incorporates a new method of changing dies that is exceptionally simple and fast. The dies simply slip into place and are held firmly in position by a lock nut—they can be replaced in less than one minute.

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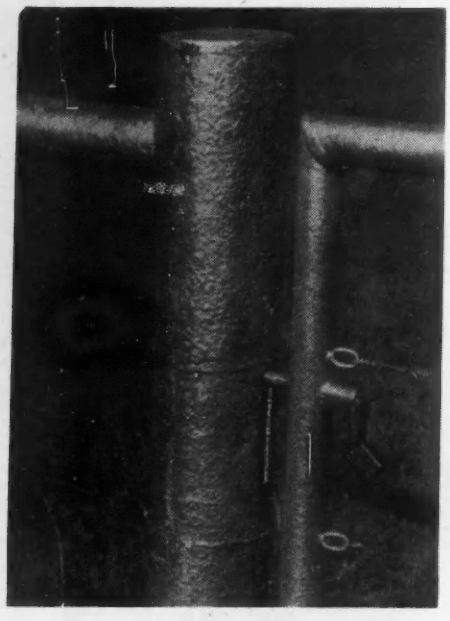

inserted into the slot of the fence post, turned at right angles, and the two steel tabs then locked together. The device is simple, secure and will operate satisfactorily even though the gate may in time sag, or, as frequently happens, be damaged by being bumped by vehicles.

How To—Mount Injector for Rod Line Motion

One of the simplest and most positive methods of operating a small treating fluid injection pump for a jack line-pumped stripper well is contained in the set-up shown in the accompanying photograph. Requiring no special fittings or equipment other than a light base for the pump, cable clamps and two lengths of light lumber, the system is installed beside the pull line and utilizes the motion of the line to operate the pump arm.

Not only does the installation simplify hooking up the pump, but variation in length of stroke may be obtained by attaching the longer arm at various points closer to or farther away from the pump. The smaller the angle between the pull rod and the longer arm, the greater will be the arc of travel of the treater pump, resulting in increased fluid being injected into the well lead line at each stroke. With such a set-up, any well can be fitted with a pump in a matter of only a few minutes.

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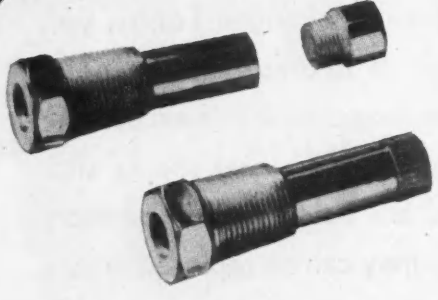

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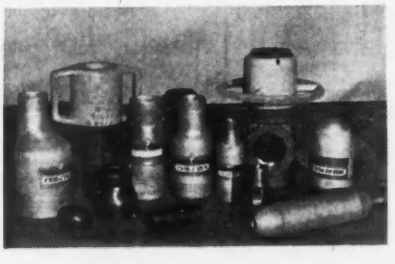

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PRODUCTION HINTS

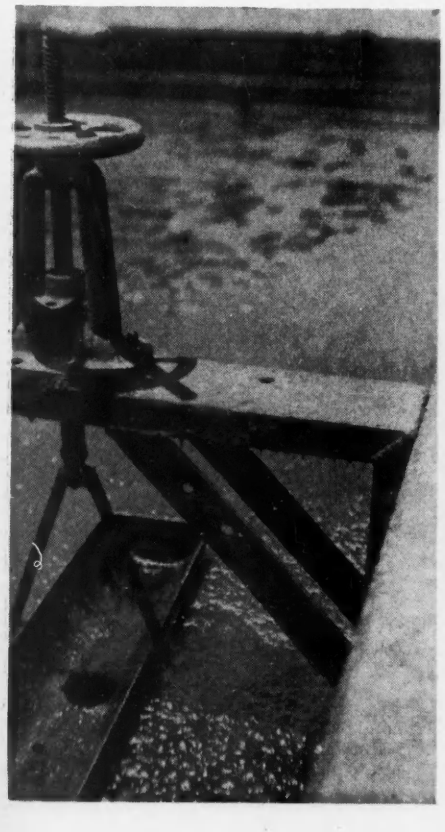
How To—

Construct Oil Skimmer

In oil fields producing large quantities of fluids, a greater percent of which is water, the separators are sometimes taxed beyond their capacity and some oil is taken out with the water. This water is normally dumped in large pits for further handling, and it is here that the oil accumulates on the surface.

Because this oil is valuable, and also because it must be removed to facilitate disposal of the water, the oil is removed and placed in storage tanks. The job of removing the oil from the salt water settling pit can be facilitated by use of an efficient skimmer such as the type shown. It is merely a trough made by splitting a four-foot section of eight-inch casing and sealing the ends. The trough is provided with a two-inch drain in its bottom where an oil-resistant rubber hose is connected to an oil sump pit located adjacent to the settling pit but at a lower elevation so that skimmed oil will gravity to the sump. The oil is picked up at the sump and transferred to storage tanks.

The method of suspending the skimmer is unique in that it employs the bonnet of a discarded gate valve which is supported over the edge of the settling pit. Two short rods are welded to the



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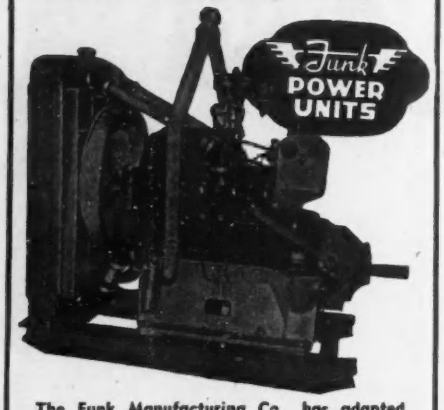

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trough and to the lower end of the valve stem, thus providing a sensitive control over the position of the skimmer. A bracket of four-inch channel iron is braced with two pieces of strap steel and bolted to the side of the settling pit as shown. The gate valve bonnet is mounted on the outer end of the bracket by two bolts thereby securely anchoring the device in position. Proper level of the skimmer can easily and quickly be adjusted to take the oil and not water from the settling pit. A short handle is welded to the top of the valve stem to prevent the trough from turning when adjustments are made.

How To—Extend Life of Rod Line Guide Posts

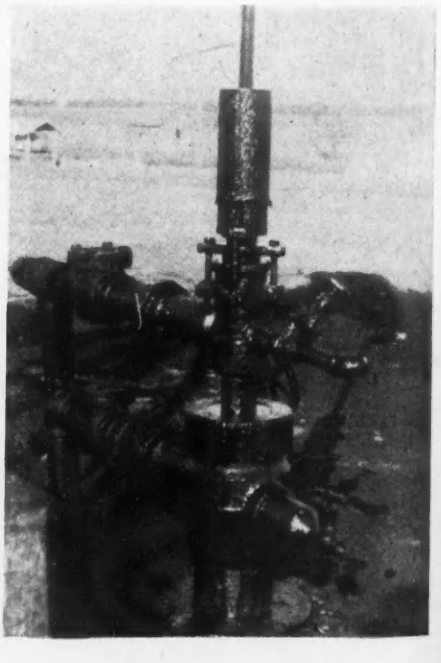
Pull rod guide posts necessarily have to be constructed of relatively soft material so rods will not suffer wear and cause expensive shutdowns. In most instances, a single large block of wood with a hole or slot bored through it, is used as a guide, the block being discarded when the hole becomes overly enlarged and allows the rod to jerk or rattle excessievly.

One company operating in a North Texas field, uses an improved guide which is made up of a pair of 4x4 blocks bolted together and held between two pipe posts set in the ground. When the blocks become worn, they are removed, turned through 180 degrees, notched to the desired initial depth, and again assembled. By using all four sides of the blocks, four times the wear can be obtained from the installation without having to install new blocks. Another feature that contributes to the long life of the blocks is the short cap of 2x4 material which is nailed across the top of the guide pieces. This cover serves to protect the end grain of the blocks from excessive damage due to weathering.

How To—Lubricate Polish Rod

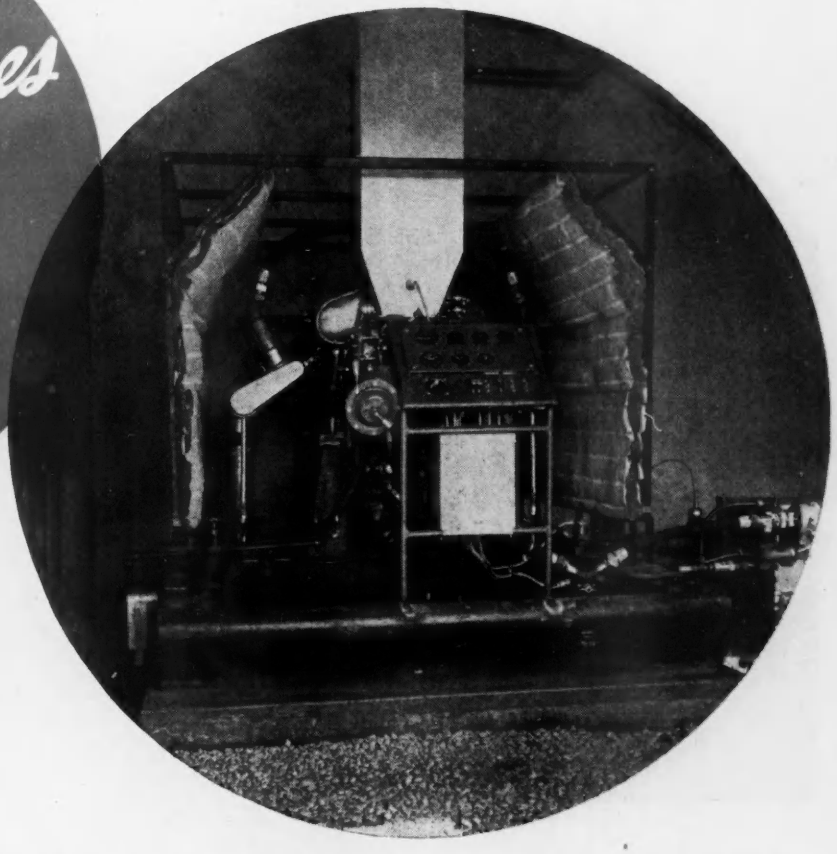
Polish rods on oil well pumping units are subject to wear and corrosion unless a sufficient quantity of oil seeps past the stuffing box to provide adequate lubrication. In order to insure positive lubrication of the polish rod at all times, one producer devised a simple lubricating box as illustrated. It consists of a small section of discarded four-inch pipe about 12 inches long and which has been brazed to the top of the stuffing box flange. It is sealed at the bottom and loaded with heavy oil so the polish rod reciprocates in a pool of oil which completely covers that portion of the rod bearing against the stuffing box each time the rod is withdrawn in the up position.

The device is equipped with two small drain plugs at the bottom which can be opened so the oil may be changed when it becomes contaminated with rain water.



Surplus Airplane Engines Power Products Line Stations

By C. C. KEANE,
Chief Engineer, Great Lakes Pipe Line Company



Setup of the engine inside the Quonset hut, showing end of heavy unitizing skid, soundproofing mats on supporting frame on two sides of the engine—the front being removed for picture-taking purposes. The control panel and governor are in the center foreground, the automatic fuel and oil-temperature regulators at the right.

BEFORE Great Lakes had completely finished its expansion program which included the laying of more than 1200 miles of new lines, erecting of eight new terminals, and the modernization of existing facilities, increasing operating capacity of the system 50 percent, we were confronted with demand for even more capacity. This need came, despite careful calculations made in 1946 when the construction was begun, which showed that under former conditions it would have taken five years to reach the traffic that was moving over the system in the middle of 1947.

To find a power plant that would enable us to increase throughput as soon as possible was our problem. Further permanent expansion, with the extreme shortage of pipe, was a matter of years and we were thinking in weeks. The decision to use secondary stations was a reluctant one, and with these we found purchased electric power was unobtainable and engine builders were far behind on orders already booked.

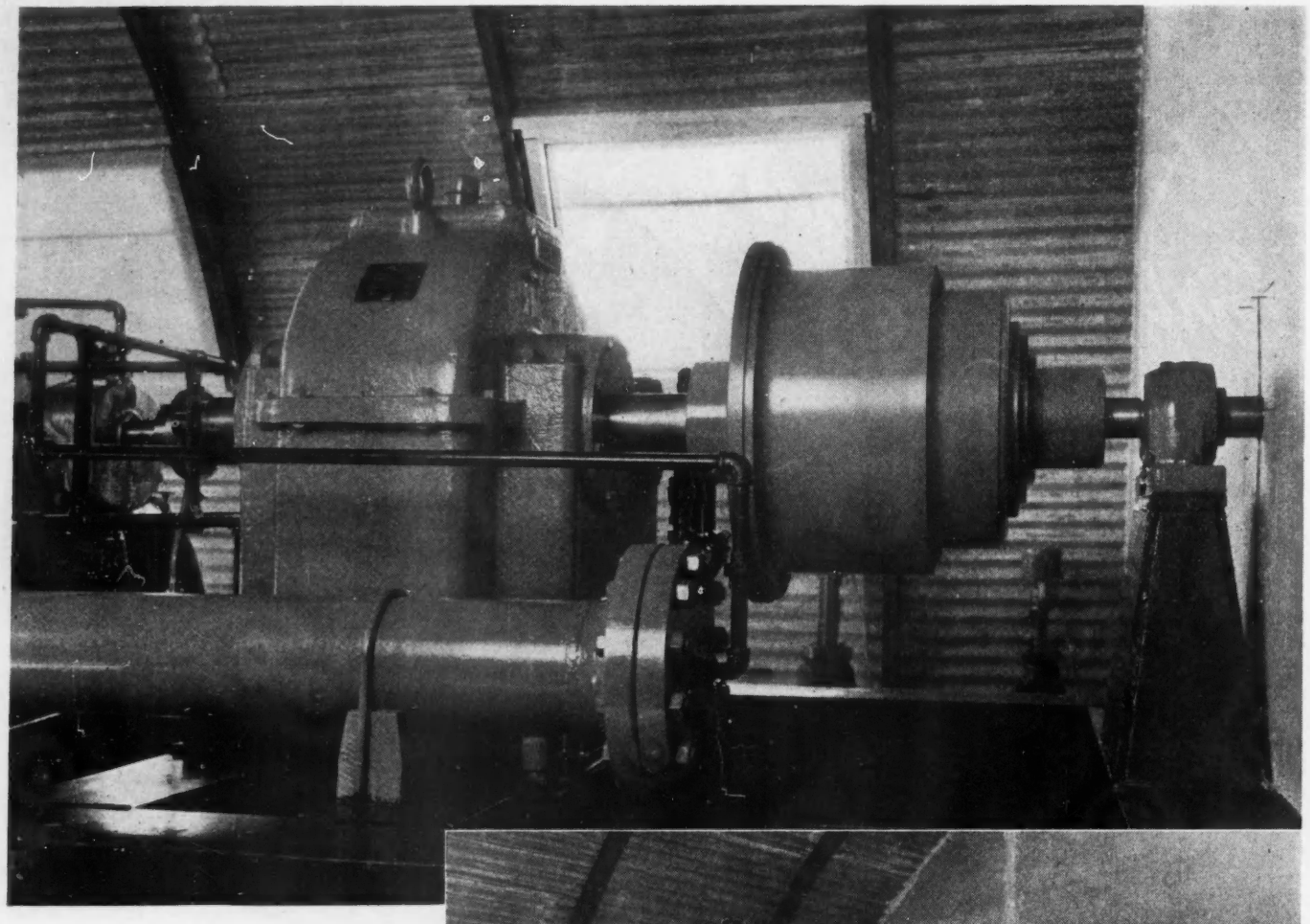
Investigation of various types of surplus wartime power plants included a thorough study of the possibilities of one of the outstanding aviation power plants of World War II. The engine finally selected was that identified in the air service as the 12-cylinder V-1710 Model E Allison; a motor which had seen strenuous service as power plant of the Aircobra and P-38 fighter planes. Use of this engine was on a basis of scrapping and complete replacement rather than maintenance of the unit under pipeline service operation.

In preliminary consideration of the Allison it was apparent to Great Lakes engineers that the unit had tremendous energy application potential if a soundly engineered power takeoff assembly and adequate cooling and lubricating systems could be devised to satisfy its requirements.

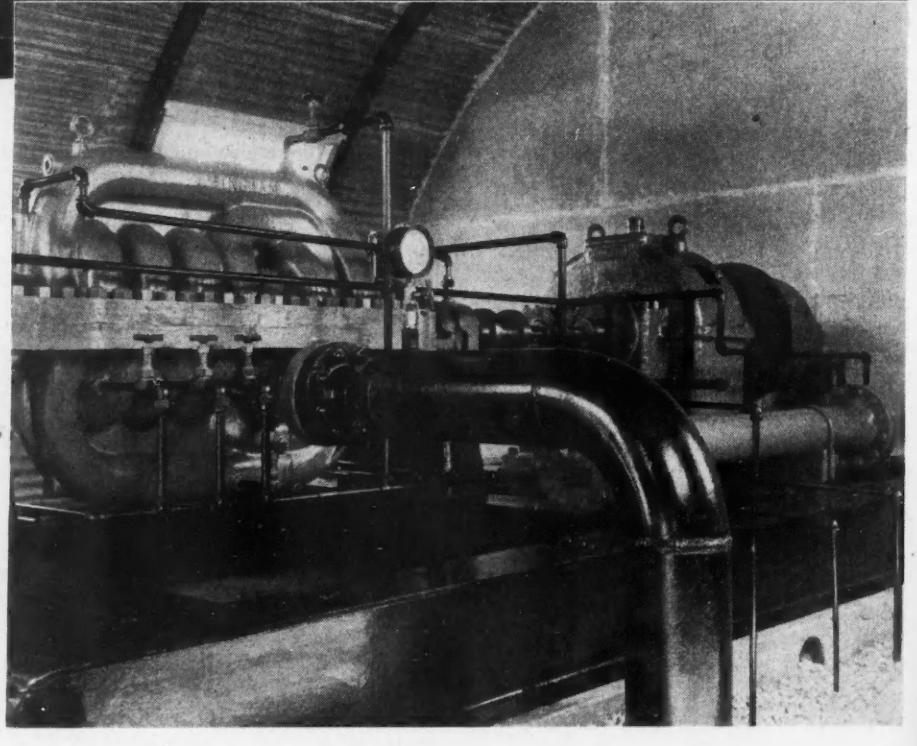
Specifications of the engine include the following: 12 cylinders in V-type arrangement each having a 5.5-inch bore and a 6-inch stroke; a piston displacement of 1710 cubic inches, a compression ratio of 6.65 to 1; a horsepower rating of 1000 at 2600 revolutions per minute, and a manifold pressure of 39.2 inches of mercury absolute; engine weight 1445 pounds; length, 194 inches; width, 29 9/32 inches, and height 37 9/16 inches.

The engine is designed to use 91 octane aviation gasoline for fuel and a 60 SAE lubricating oil. In mild weather it is cooled by water and in winter a 60-40 mixture of water and ethylene glycol is used to prevent freezing. It has a builtin water circulating pump, a lubricating oil gear pressure pump and

THE OIL INDUSTRY is making many novel uses of surplus war materials which, in time of peace, are helping in the struggle to keep pace with the ever-augmenting demand for petroleum and its products. But none of the applications is more striking than the "tying down" of an airplane engine to the everyday grind of powering a pumping station. This article describes the manner in which a motor is adapted to pump drive, and details some of the engineering which went into the job.



Passing through the firewall, the drive shaft enters one side of the air-actuated clutch. Adjoining the clutch is the stepup gear unit; in the foreground the heat exchanger using line fluid for cooling the oil bath in the gear unit.



Suction side of the seven-stage centrifugal pump which, at 900 pounds operating pressure and 2300 revolutions per minute has a throughput of 41,000 barrels per day. High-stage fluid is bled through small line at top of unit for flow through speed-increaser heat exchanger.

two lube oil scavenge pumps. Using two spark plugs in each head, the ignition is energized by a magneto running at 1.5 times crankshaft speed. The magneto is air-cooled through a draft duct fed by a small compressor unit.

In operation air is drawn through the carburetor venturi tubes to the inlet of the supercharger. At that point fuel is injected through a spring loaded jet valve and in the fuel phase change that follows, the air charge is cooled with a consequent increase in density. The fuel air mixture is distributed through the intake manifold to the respective cylinders and is fired following conventional electric ignition principles.

The adaptation problem resolved itself around a pneumatic flexible clutch coupling soft enough to prevent torsional disturbance from developing between the speed increaser gear and the engine, a stepup gear rugged enough to withstand the high pitch line speed, a high speed coupling conservatively loaded and a multi-stage pump radially and laterally balanced. The completed assembly is mounted on a steel skid of heavy H members and weighs about ten tons.

In the pump station assembly the skidded unit is bolted to a monolithic concrete block housed in a Quonset hut. The hut's diametrical dimension is 20 feet. An asbestos board firewall separates the engine from the air-energized

clutch, stepup gear and multi-stage pump. A novel arrangement is the cooling of the stepup gear lubricant by pipe line product flow from the main pumping unit's second stage suction through a heat exchanger to the first stage inlet. No water is used in this scheme.

The pipe line circuit, following a conventional arrangement, courses through a horizontal basket strainer into a heat exchanger that uses a common tube bundle for dissipating the heat from the engine lube oil and jacket water, A bulkhead separates the water and lube oil chambers of the exchanger. After leaving the exchanger the pipe line product passes through the main line pump to the outgoing high pressure circuit.

Temperature blending valves maintain the heat of the engine lubricant and water at the recommended levels. A cotton waste filter in conjunction with an airmaze strainer keeps the lube oil clean. The volume in circulation is approximately 70 gallons. The jacket and water system are fully closed with an expansion tank floating on the coolant pump suction. An outside electric supply furnishes energy for lights and auxiliary power and when passed through a selenium rectifier the resultant direct current is used to charge the starting battery.

A filling station type compressor supplies air for energizing the pneumatic clutch coupling and engine speed regulator.

The engine had no flywheel or governor, and design of equipment to provide these essentials provided many interesting problems. Flywheel effect, as determined from the Wr^2 of the airplane propellor, and its reduction gear, was built into the pneumatic coupling.

The governing problem was not solved so easily. Initially it was thought that a hydraulic governor with a flyball pilot control would provide a solution, but the method of drive, connecting linkage, and high purchase cost combined to cause rejection of this system. Since the engine was equipped with a throttle rod and a parallel link motion that automatically maintained rpm for different load conditions, it was reasoned that a pressure governor, air actuated by a Taylor fulscope, which in turn adjusted its position to satisfy predetermined pipe line pressure conditions, would solve the problem.

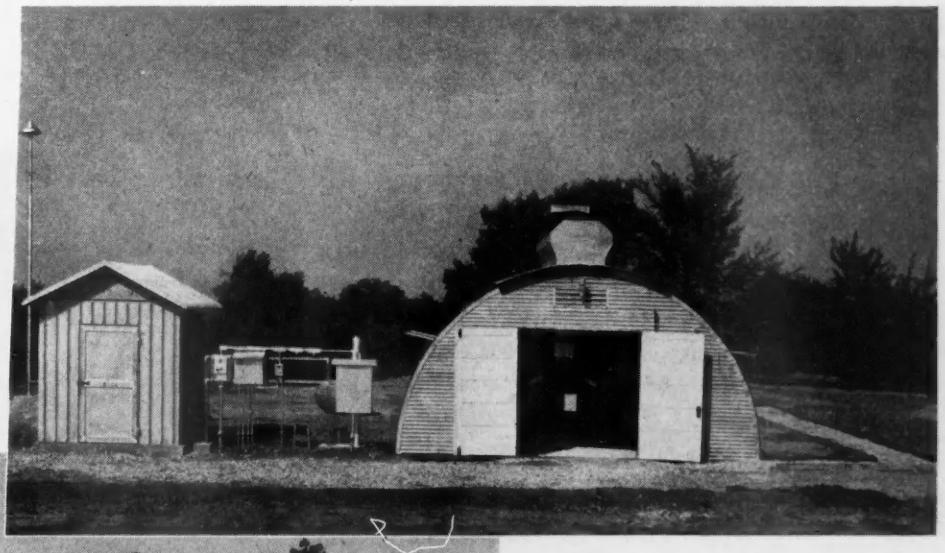
After experimentation and minor adjustments the fulscope system coupled to a diaphragm motor for throttle control provided a speed regulating range that fully satisfied fluctuating load conditions.

Auxiliary equipment includes an electric fuel booster pump for starting, an engine control panel with tachometer, supercharger pressure gauge, lube and coolant temperature gauges, lube pressure gauge, carburetor air temperature and miscellaneous switches, all surplus war supplies. Appropriate overspeed and temperature devices protect the engine from damage. The assembly is started as a unit and after a short preliminary warm up is placed in pipe line service.

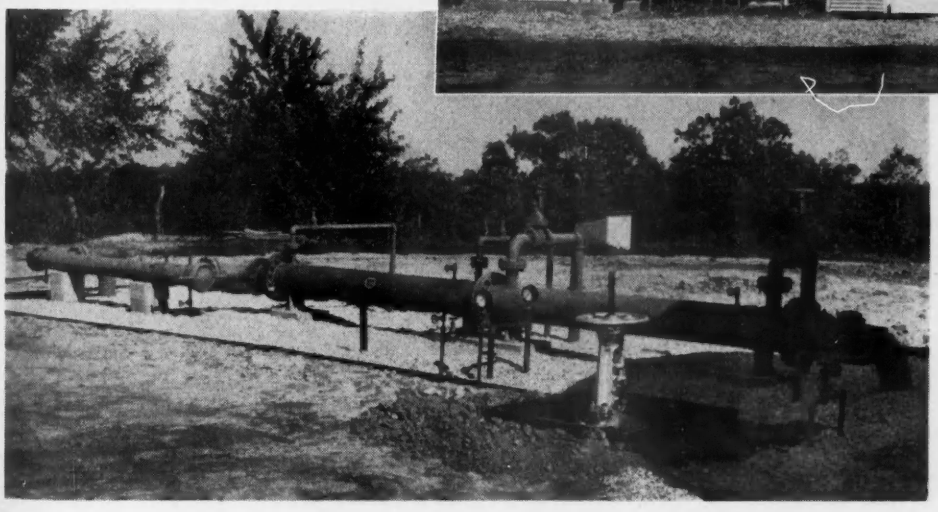
Noise in the threshold of feeling range when the unit is at speed is so intense that the engineroom side of the Quonset was sprayed with a heavy coat of acoustical sound absorbent material and this is supplemented by an engine box lined with a four-inch thick acoustic blanket. With such an arrangement fundamental sound and reverberated sound are damped to a degree that permits operators to work without the danger of damage to their hearing.

The station sump is pumped out by a stream actuated eductor. Telephone communication is available in an acoustical proofed booth separate from the pump station.

The unit is designed to pump 40,000 barrels per day against 900 pounds per square inch with an overall efficiency of 76 percent. On test runs it has pulled loads of 1000 horsepower for two hours without apparent distress. With a full supply of material on hand, a completed station can be installed and running in four days.



Typical secondary pumping station housed in Quonset hut, with outdoor control panel for outside power circuit. The small house to the left is the operator's "office," which shelters the phone used for dispatching and station records.



Heat exchanger system for handling engine coolant in main section and oil coolant in short baffled portion of unit, both in counter flow to products through exchanger shell. Blending valve maintains fixed temperature differential between incoming and outgoing coolant.

Skimming Pit Cleans Runoff Water

By ELTON STERRETT

PREVENTION of pollution of surface streams, no less than the protection of underground water sands, is a responsibility of the oil company. Not only is it charged with the task of removing from runoff water the oil, sludge or other petroleum waste which may escape from the piping and tanks of the property, but it must also insure that the water flowing beyond its boundaries is of a nature which will not injure livestock, impair vegetable growth, or harm aquatic life. These requirements are specified by various statutes and fish and game laws, and are also emphasized by an even more potent unwritten law—that of maintaining good public relations.

The problem of waste control on the lease is magnified many times on the pipe line tank farm. Instead of a battery of four of five tanks at most, the pipe line station may include a tank farm with as many as 100 units scattered around it; each within a firewall, to be sure, but at the same time draining into a common ditch or at least with all surface flow eventually reaching a common stream. And, even though a burning or other waste disposal pit is a part of the farm, occasionally more or less oil will escape, find its way through the firewall drains, and enter the surface drainage ditches. Once free of the firewall, the oil must be trapped before it can leave the company property.

For this, some type of skimming trap is customarily used to allow the oil to float to the surface of the water, come to rest, and then be removed by skimming or, occasionally, by transfer to or locally burning, in a pit far enough removed from other installations to eliminate fire hazard.

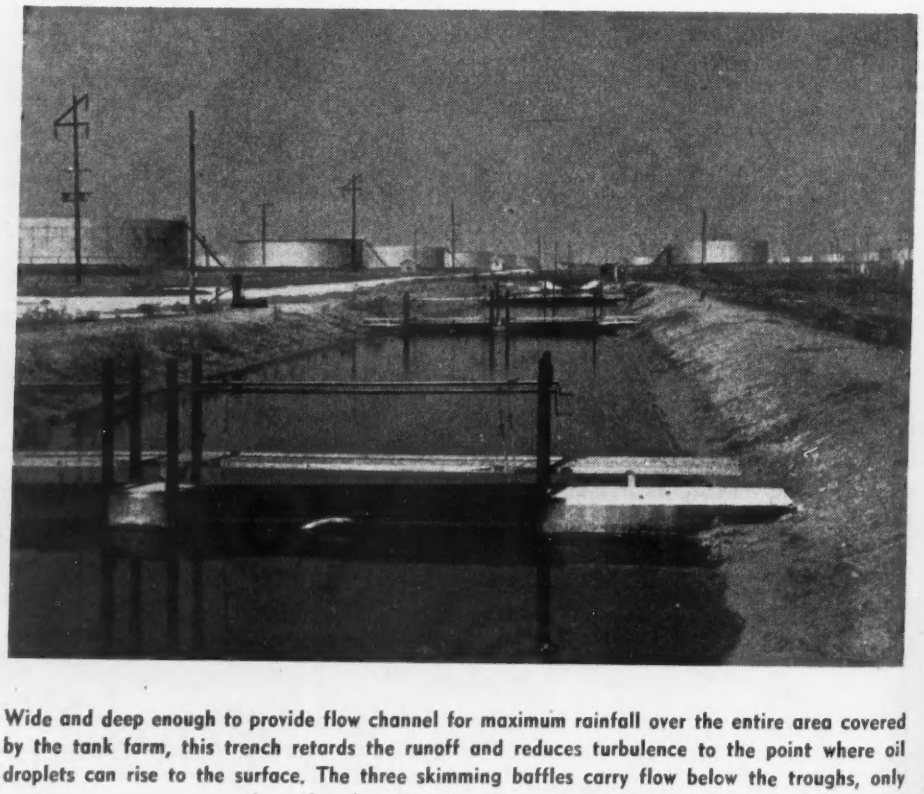
Pit Size

The pit must be designed to take the entire runoff from the farm. It can not be operated on a selective basis, although such a plan would adequately care for losses sustained during tank cleaning or an occasional line break. The size of the pit, therefore, is directly related to the area of that section of the station yard which carries tanks, lines—either buried or surface—and other equipment through which oil is handled. The area of the pit, and the cross-sectional dimensions as well, likewise are dependent on the maximum rate of rainfall. A pit which would adequately clear the oil from the farm runoff if four inches of rain fell over a 24-hour period might, obviously, fall far short of handling the job if the same amount fell in 30 minutes.

At the Webster Station of the Humble Pipe Line Company a skimming pit has been designed and installed which meets all the requirements listed and which insures untainted efflux to the stream which borders the farm and serves to carry away rainfall.

The pit is formed by excavating and throwing up a dike along the edge of the raised section of the farm on which the tanks are located, with flow entering the upper end of the long, straight excavation. Width of the pit is uniform, as is its depth. Sand and silt washed from the farm collect in a pre-pit sump, from which they may be removed before they escape into the pit proper, there to reduce flow area and affect the calculated flow past the baffles.

Three baffles are installed, dividing



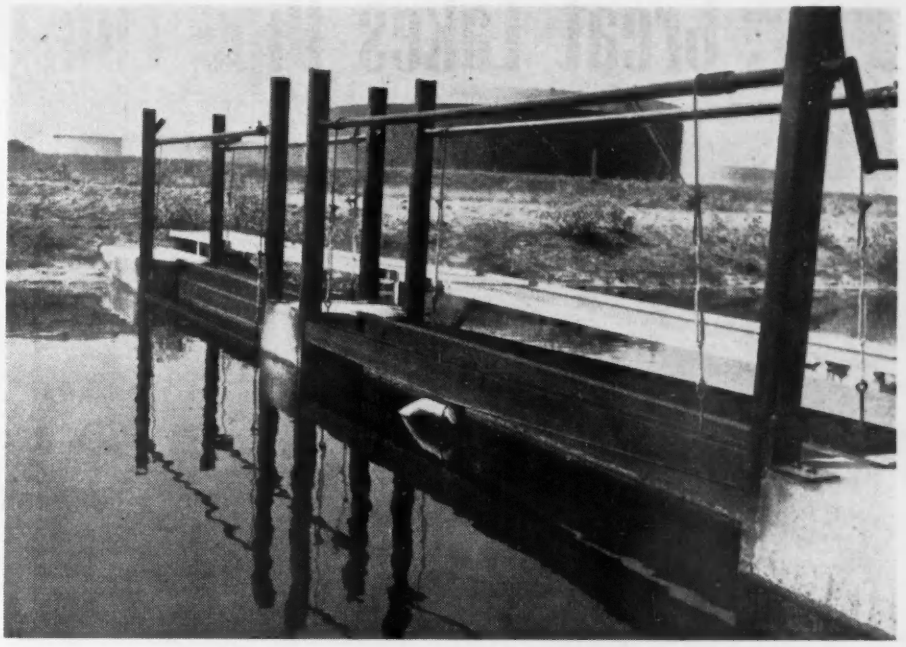
Wide and deep enough to provide flow channel for maximum rainfall over the entire area covered by the tank farm, this trench retards the runoff and reduces turbulence to the point where oil droplets can rise to the surface. The three skimming baffles carry flow below the troughs, only the surface layer entering the transverse pans.

the pit into four approximately equal sections. The first, between the settling basin and No. 1 baffle, acts as an additional settling basin, the slowing of flow due to the wider cross-sectional area being sufficient to cause particles carried into the unit to drop out before reaching the first skimming trays.

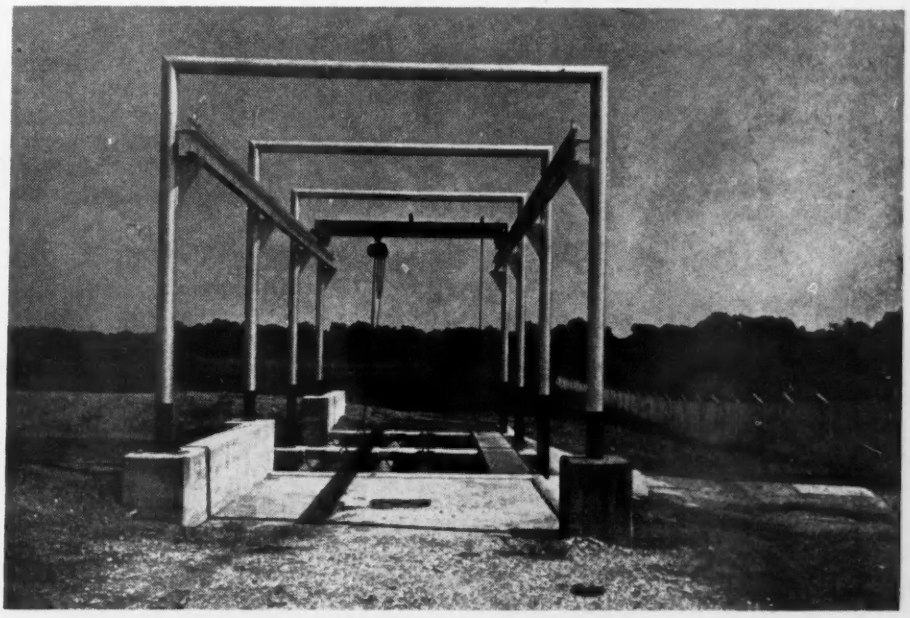
Skimming Units

Each baffle consists of two concrete abutments and a central pier, set deeply into the earth to resist washing by the current when heavy runoff is being handled. Four skimming pans are suspended in the gaps thus formed, a pair extending from each abutment to the central pier. These pans are rectangular in cross-section, with the bottom sloping downward to the center. A two-inch elbow, welded into the bottom at its lowest point, connects through hose to the sump-pump suction system. A float-controlled pump on the bank removes the fluid when it has collected in the sump, returning it to be reclaimed, the oil again being made usable and the entrained water again entering the skimming system.

The skimming pans are fitted into steel channels which are cast integral with the concrete, the pans being raised or lowered in these channels through the medium of a two-inch joint of pipe which spans the gap between bearings, and on which two flexible wire lines are wound as on a winch drum. Crank and ratchet at the steel channel on one of the abutments provide lifting power and for locking the pans in place at a desired height. Turnbuckles in the hoisting lines allow the pan to be leveled precisely so as to distribute the skimming across the entire width of the upstream lip.



The nearer skimming pan is raised to show the sloping bottom and the connection to the sump pump, while the matching unit beyond the central pier is set so that the upper edge is aligned exactly with the surface of the water. Turnbuckles and the pipe serving as drum for the adjusting lines insure accurate leveling of the entire pan and avoid excessive water intake.



Paired sets of hay boxes, set across the pit at the weir or dam at the outflow end, trap any droplets of oil that may escape the three skimming pans. The overhead crane and truck apron provide means for changing boxes with a minimum of labor. The boxes may be renewed individually, or one side blanked off for complete change, while flow is through open bay.

Hay Boxes

After passing the three baffles and being skimmed by the six pans en route, the runoff water reaches the combination weir and hay box unit where final purification is effected before the flow is discharged to the nearby stream. This unit, like the baffles, is divided across the center by a pier, each section being equipped with four boxes through which the upper portion of the flow must pass before it is discharged. These boxes are filled with hay, marsh grass or excelsior so that the flow is broken up and the fluid effectively cleaned of any remaining droplets of oil which, on contacting the filler material of the boxes, become attached thereto or are trapped in the interstices of the packing.

Each hay box is equipped with a lifting eye, set at the balancing point, to eliminate binding in the narrow end slots in which the units fit. The box is removed, emptied of its charge of waste-collecting material, refilled, and replaced. This change may be made progressively, if conditions require, one of the four boxes at a time being recharged while the other three temporarily carry the flow. If weather permits, one side may be blanked off by a drop baffle and all four of the boxes removed at one time, while the relatively light flow is diverted to the untouched side of the unit.

Posts and paired channel rails carry a traveling crane and chain hoist, so that the change can be made with a minimum of personnel. The craneway spans not only the two bays in which the boxes are installed, but also extends shoreward on one side far enough to cover a flat concrete apron on which a truck may be spotted, allowing the boxes to be transferred between pit and truck with handling work all performed by the hoist.

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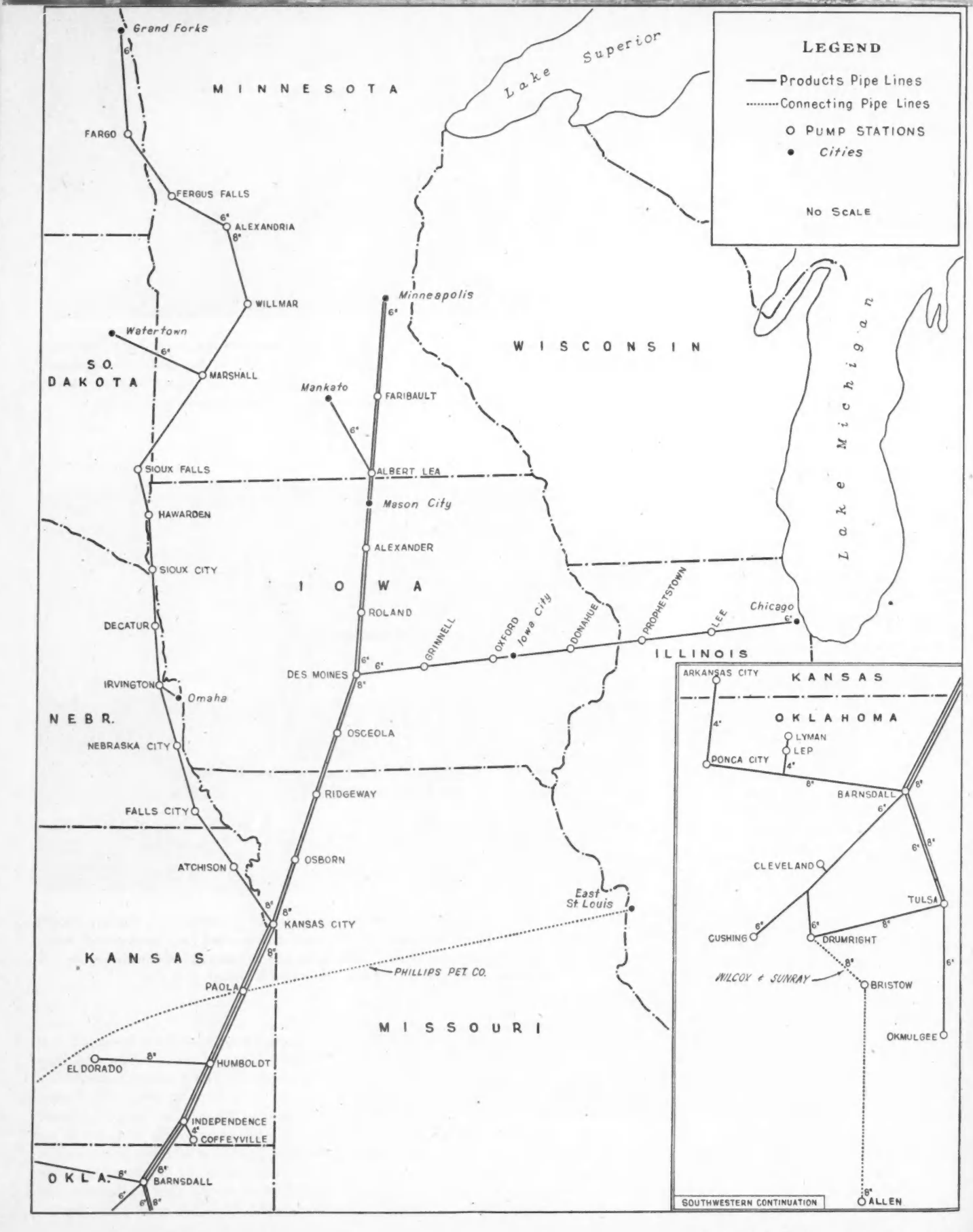

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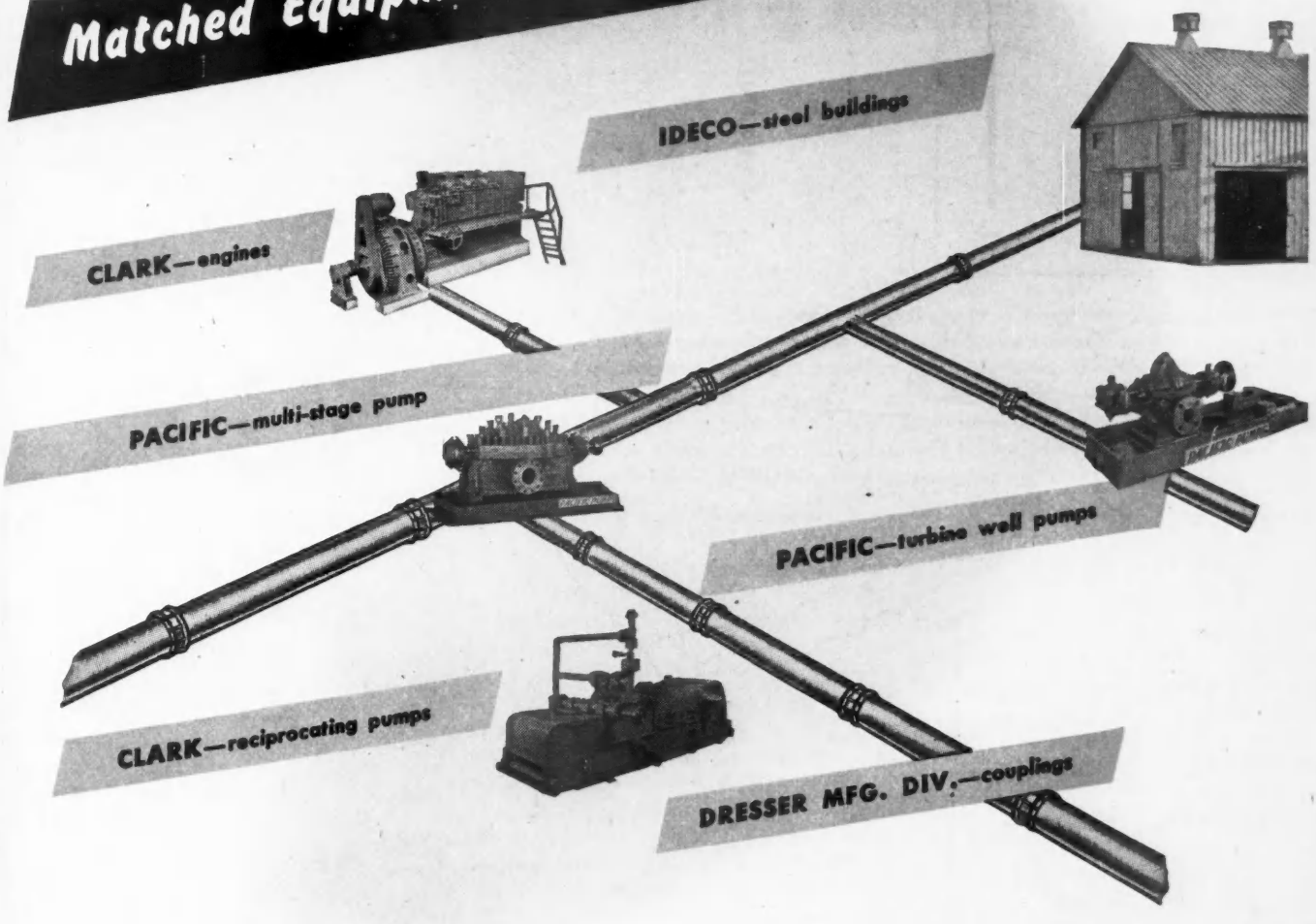

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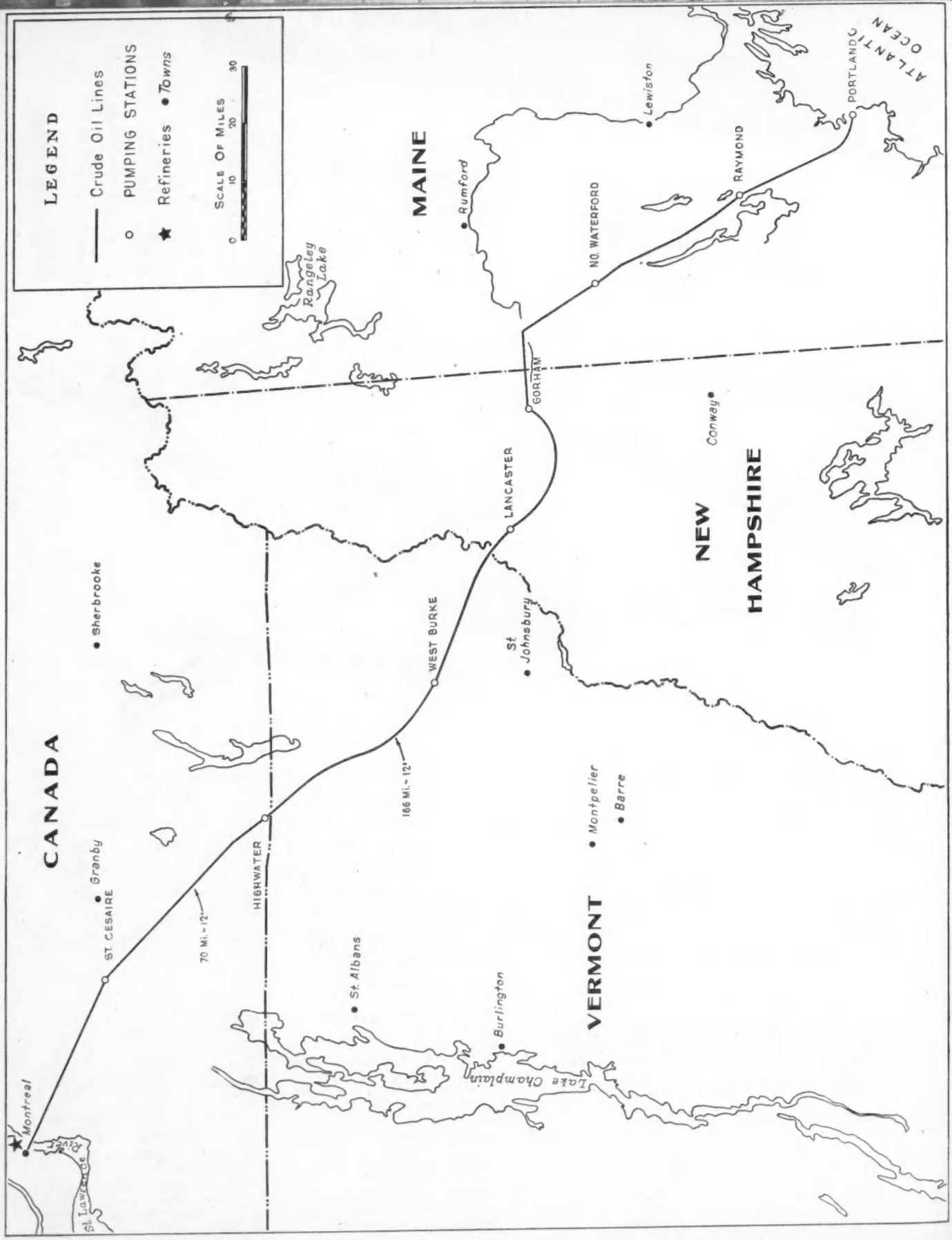

Effect of Lubrication In Reducing Mechanical Wear

By W. M. SOPHER,
Union Oil Company of California

GENERAL application of petroleum lubricating oils to combustion engine lubrication is widely known and understood. There are, however, certain aspects of the problems encountered in engine lubrication which, it is felt, have been lightly considered, or the importance of which has been either over-emphasized or under-emphasized. In this article, substantially in full as presented before the West Coast Transportation meeting of the Society of Automotive Engineers in Los Angeles, the author develops the principal factors affecting lubricant film action.

ONE of the principal factors concerned with lubrication processes and probably one that receives only casual attention is the matter of the surfaces to which the lubricant is applied. For some reason which is not apparent the rubbing surfaces are always considered to be exposed portions of rigid mechanical members. This property of rigidity, as applied to mechanics is not the perfect effect which it is generally accepted to be (Figure 1). There is abundant evidence to prove that a certain eccentricity of motion away from calculated geometric patterns exists between moving surfaces, due to the absence of exact rigidity.

While this variation in motion pattern apparently is of little significance where full fluid film lubrication is in effect, its importance becomes more imposing where partial films or boundary films exist.

When partial film lubrication is employed, the rugosity of the surfaces themselves exerts a depreciating effect upon the lubrication and if coupled with eccentricity of motion, it is apparent that high loading at the tips of the asperities can occur at localized points.

The usual concept of bearing surfaces appears to be in terms of projected area in square inches or fractions thereof. However, closer scrutiny reveals that due to the rugosity of the surfaces, the entire available area is not under load, i.e., only the points in contact offer support. Thus, for illustration (Figure 2), if we consider a one-inch cube weighing one pound resting upon a surface and both surfaces are perfect, we have a weight of one pound equally distributed over an area one inch square or a load of one pound per square inch. This would mean that each one-millionth of the square inch would have one-millionth of one pound as a load. If, however, the surfaces were not exact, it might be found that although the area and total load were the same as before, that each one-millionth of the square inch would carry the load in different proportions. Thus, perhaps only 500,000/1,000,000 of the total area would be carrying the total load of one pound or an actual increase in load pressure per working area of 100 percent.

While the foregoing is elementary, it will serve as an adequate example of the stresses present in bearing surfaces where partial film lubrication is in effect.

Cylinder Bore Wear

Combustion engines of the reciprocating type have long posed the problem of cylinder bore wear. It has been shown by Williams, Moore & Kent, et al, that corrosive effects play a large part in accelerating the wear in this area (Figure 3). The effect of corrosion apparently is such that erosive wear is greatly stimulated over the area exposed to corrosive compounds.

The fact that corrosive effects play such an active part in cylinder bore wear would seem to indicate that lubricating oil films in the area are comparatively unstable, or at least intermittent. Other work by Taylor using a "motored" engine shows in terms of friction that with increase in load and speed, substantial increase in friction is experienced in the cylinder (Figure 4), while journal bearings operating under complete film lubrication show no appreciable effect. Inasmuch as the viscosity factor of the lubricant used was constant at all points, the

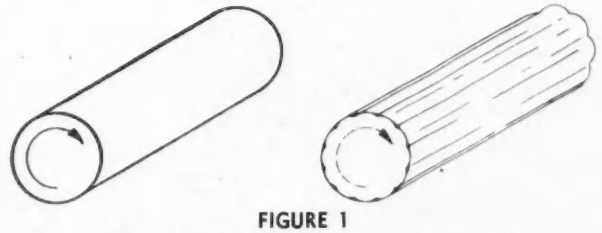

FIGURE 1
Left: Perfect rigidity. Peripheral motion—circular.
Right: Imperfect rigidity. Peripheral motion—serrated.

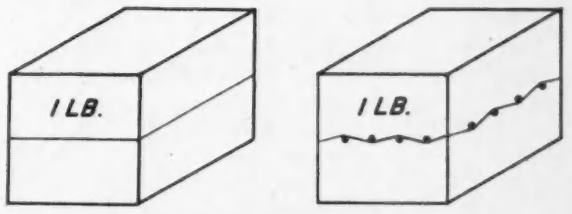

FIGURE 2
Left: Perfect surfaces. 1 lb. psi contact load.
Right: Imperfect surfaces. 2 lb. psi contact load.

assumption is that the frictional increase was due to the partial film lubrication of the cylinder bore.

If consideration and credence are given to the $\frac{ZN}{P}$ value of viscosity as applied to lubrication, it is rather apparent that cylinder lubrication is largely a process of partial films. Low values of $\frac{ZN}{P}$ are generally conceded to yield boundary films or partial films. It, therefore, appears logical to conclude that because of variation in piston speed (Figure 5) O-N feet per minute and as the heat of the combustion chamber exercises a substantial viscosity reducing effect on the oil film, $\frac{ZN}{P}$ values will largely be in the low range (Figure 6).

Inasmuch as many factor bear upon the viscosity of the lubricant to diminish its effect, it seems reasonable to provide supplementary means of retarding surface contacts, or, as a secondary alternative, to mitigate the destructive effects of surface contacts under motion.

Considerable work has been done along these lines and has resulted in the present compounded oils.

In the case of retarding surface contacts by supplementing viscosity, so-called oiliness agents or polar compounds are to some extent being utilized. Here the intent is to employ the forces of inter-molecular attraction (Figure 7) rather than the viscosity or shear resistance of the lubricant, as a means of interposing an unctuous interface between the rubbing surfaces. Presently the limitations of this approach appear to be due primarily to inadequate thickness of the coating. According to those who have given considerable time to the study of surface phenomena, it seems that molecular orientation is limited to a depth or thickness of five or six angstrom units.

Anti-Fusing Agents

The secondary alternative mentioned, i.e., mitigation of the damage accruing from surface contacts, may be effected by the use of anti-fusing agents such as compounds of sulfur, chlorine, etc. The principal involved apparently hinges upon the conversion of the surfaces under load. Thus, where iron surfaces are involved, the stress points are prevented from welding by being converted into oxides, sulfides, chlorides, etc. While the process is not completely understood, there is sufficient evidence to show that when compounds of the types mentioned are used, a substantial reduction in erosive wear is experienced when loads are high and lubricating films are thin. It might be said that lubrication of this type substitutes mild corrosive wear at points where violent erosive wear would occur if anti-welding compounds were not present.

A discussion of the subject of lubrication would not be complete unless some attention was given to the service properties of the lubricants themselves.

Combustion engine lubrication is usually achieved by recirculation of the oil from a central reservoir. The reservoir may be the crankcase itself or a separate tank such as employed when the engine operates with the sump dry. In either instance, the same oil is used over and over again. During the period of use, the oil is exposed to thermal effects, oxidation effects and contamination from internal and external sources.

In the past it has been the practice to change the oil at some preconceived time, based on the time the oil was in service in hours, or as in the case of vehicles, on the number of miles run.

Inasmuch as laboratory facilities are not generally available to the greatest percentage of users of lubricating oils, it was not possible to recommend oil changes based on oil condition, therefore, the intervals specified, i.e., 1000 miles as in the case of vehicles and 60 hours for others were adopted. The intent here apparently was to permit the user of lubricating oils to extract a reasonable percentage of the lubrication which he purchased, from the oil and simultaneously allow a wide margin for unanticipated effects which might seriously depreciate the lubricating value of the oil.

These precepts were handed down many years ago and generally have been accepted without contention.

Early studies of the oxidation characteristics of the various hydrocarbons used as lubricants indicated to a degree their susceptibility to chemical change during service. Subsequent work has attempted to evaluate these changes from the standpoint of their effect upon lubrication. Likewise, compounds produced as a result of thermal decomposition have received attention. The literature is so filled with details of exploratory experience in these fields that it appears unnecessary or perhaps impossible to credit any single group or individual contribution as authority for conclusions reached here. However, a common note of concurrence is struck by all concerned that the significant factors involved in lubricants undergoing physical and chemical change in service is quantative rather than qualitative. Thus, the question is not so much, has the neutralization number increased, but rather, how much has it changed? Likewise, not so much, has the kinematic viscosity of the oil increased, but rather how much has the kinematic viscosity changed? etc.

It is apparent that all organic lubricants undergo some change even with the slightest degree of use or exposure. The practical application then of such materials requires that their service limitations be calculated upon their capacity to perform the task assigned, rather than upon abstract values which at best are more indicative than conclusive.

Past experience with the use of petroleum oils as combustion engine lubricants has indicated that certain deficiencies were present; thus, their tendency to oxidize and become thick with the attendant increase in acidity was a common experience. Their inability to properly exercise a desired cleaning action on engine parts and to harmlessly disperse fuel soot and polymers formed from products of decomposition, etc., were serious and conspicuous defects. Notwithstanding the foregoing shortcomings of straight petroleum lubricating oils, their service cycle was set as indicated earlier in this paper.

Modern engine design equipped with adequate ventilating and screening devices to exclude abrasive particles from cylinders and lubrication systems, coupled with modern compounded lubricat-

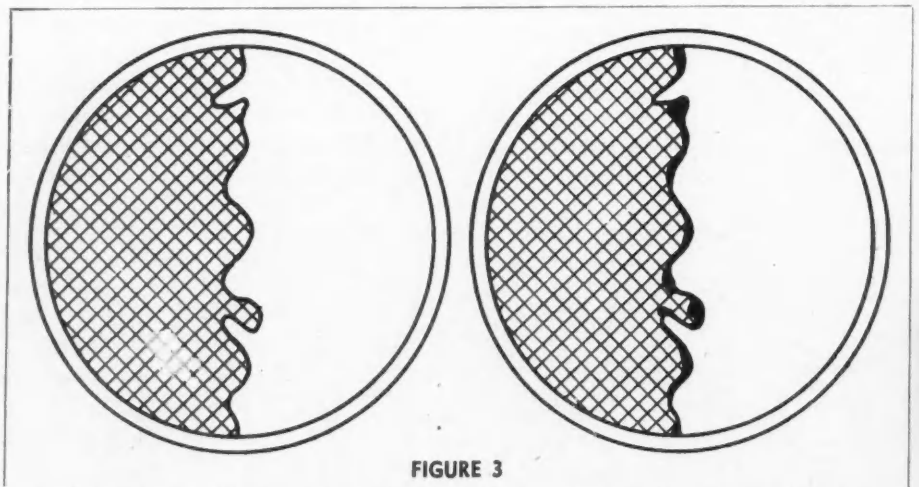

FIGURE 3

Left: Magnified profile of cylinder wall surface. Non-corroded asperities strong and durable. Right Magnified profile of cylinder wall surface. Corroded asperities frail and evanescent.

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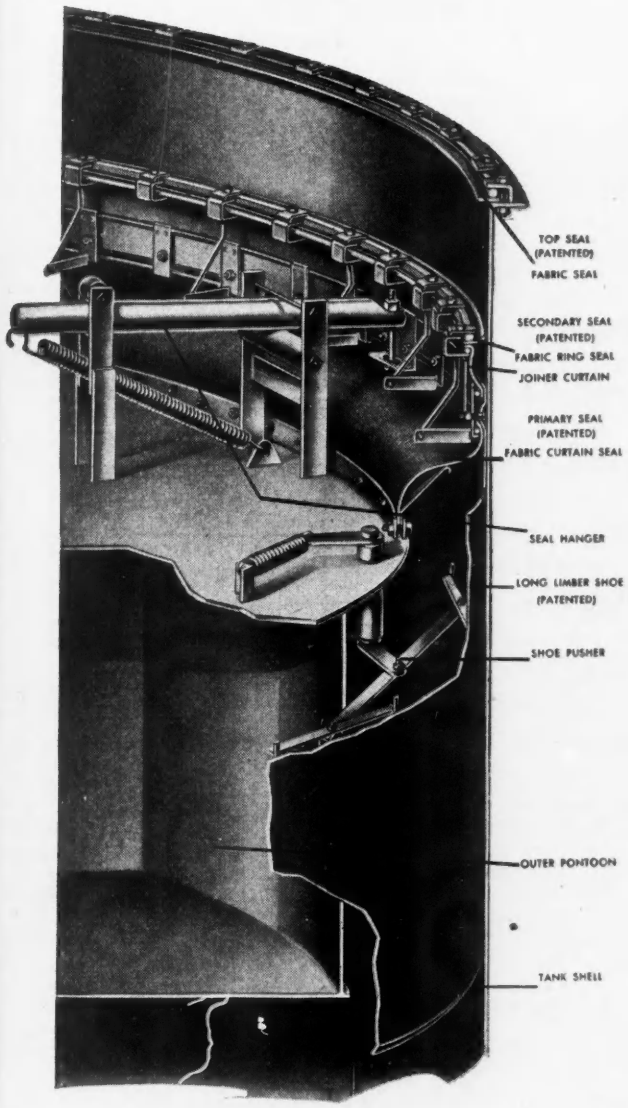

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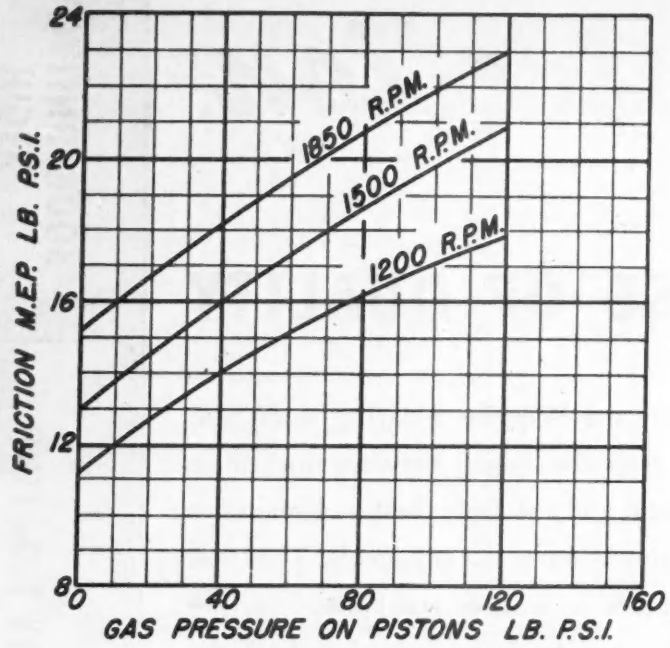
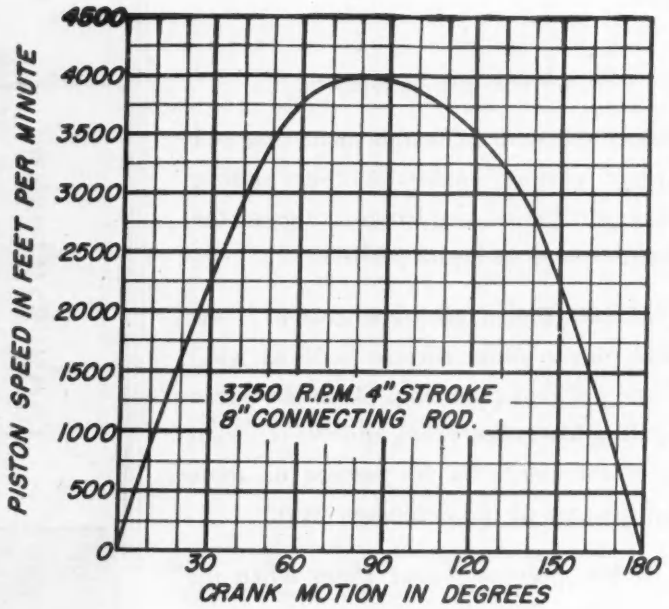
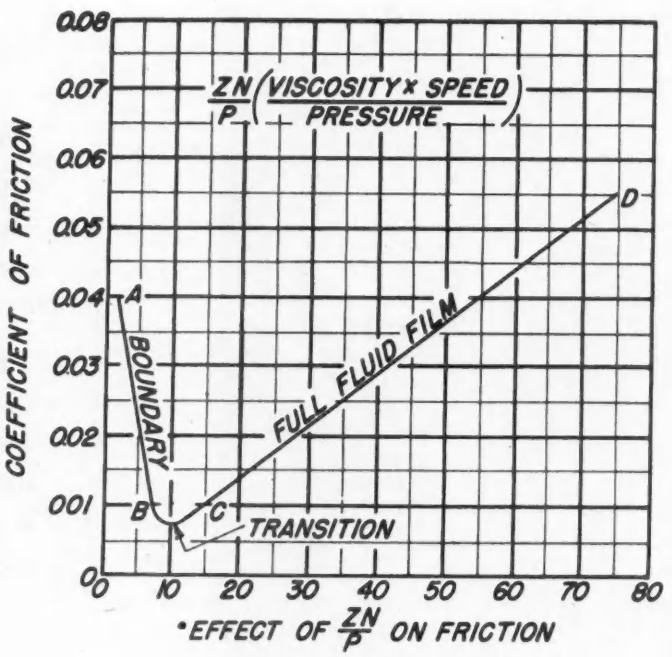


FIGURE 4 (left)
Effect of gas pressure on engine friction.

FIGURE 5 (lower left)
Variation in piston speed with crank position.

FIGURE 6 (lower right)





ing oils, presents a new perspective for viewing oil change cycles.

If we regard the lubricating oil as a lubricant having a specific series of functions in an engine and not as a panacea to correct and compensate for all the ills that might be attendant to engine operation; if we rely on the engineering accuracy built into air- and oil-cleaner design and assume reasonable maintenance of such devices, the oil change cycle can be greatly extended, using modern compounded lubricants.

It should be added that over the past 20 years many improvements have been made by engine builders in the matter of crankcase ventilation. The improvements permit a more rapid and complete release of condensable compounds from the oil storage area and provide for admitting sufficient, abrasive-free air to the engine to insure reasonable freedom from stagnation. Better control of engine operating temperatures through more effective design of cooling systems and the use of thermostats likewise provides additional means for mitigating oil contamination.

Earlier it was indicated that "oil condition" should serve as the criterion for ending the service cycle and that quantitative derogative effects were of more significance than qualitative changes alone. Conation to accept the foregoing permits further expansion along the lines of practical application to engine lubrication.

The lubrication of combusion engines requires that certain percentages of the oil, circulated in the lubrication system, be consumed by the engine. The rate of consumption is largely controlled by the mechanical condition of the engine and the speeds of operation. There are other factors which also have a bearing on oil consumption, but they will not be considered at this time.

Oil Conditioning

If this portion of the discussion is confined to engines used to propel vehicles, it will be noted that the oil supply is carried in the engine, usually the crankcase. As oil is consumed, it is necessary to replace it from time to time so that the prescribed volume, indicated for proper lubrication, is at the correct level. Thus, it is apparent that new oil is added to used oil at varying intervals.

The effect of this "sweetening" action on the used oil may be considered in terms of over-all "oil condition." Generally, "oil condition" is a function of the

amount of makeup oil added during a given period of time or over an interval measured by miles.

Due to the oil consumption factor, the lubricating oil will ultimately reach a stage of equilibrium from the standpoint of "average age" and will get no "older" (Figure 8). The gauge of quality then for any given lubricant would be based on satisfactory "oil condition" at the greatest anticipated "average age."

Comparative test work, both field and laboratory, reveals rather interesting data. Using high quality, high viscosity index base oils, one series compounded while the other series were straight mineral oils, it was shown that in every instance the specially compounded oils displayed a better "oil condition" at the expiration of 5000 miles of service, than did the non-compounded base oil of the identical type at the end of 1000 miles service under like operating conditions.

Furthermore, those engines which were dismantled and inspected appeared not only cleaner but also showed lower manifestations of wear with the compounded oils.

Figure 8 compares "oil condition" in miles against actual miles driven, using three rates for adding makeup oil. In each instance, it is seen that the "oil condition" ordinates asymptotically approach a constant.

The asymptotic ultimates of the three ordinates shown reveal that where the oil consumption rate is greatest, the "oil condition" in miles is more satisfactory. Careful study of the operation of fifty vehicles, of various makes, under a wide range of operating conditions, discloses that only in rare instances does the "oil condition" exceed 5000 miles.

Engines using volatile fuels such as gasoline, kerosine, butane, propane, and natural gas will largely display a lower lubricating oil dilution percentage than those using heavier fuels such as diesels.

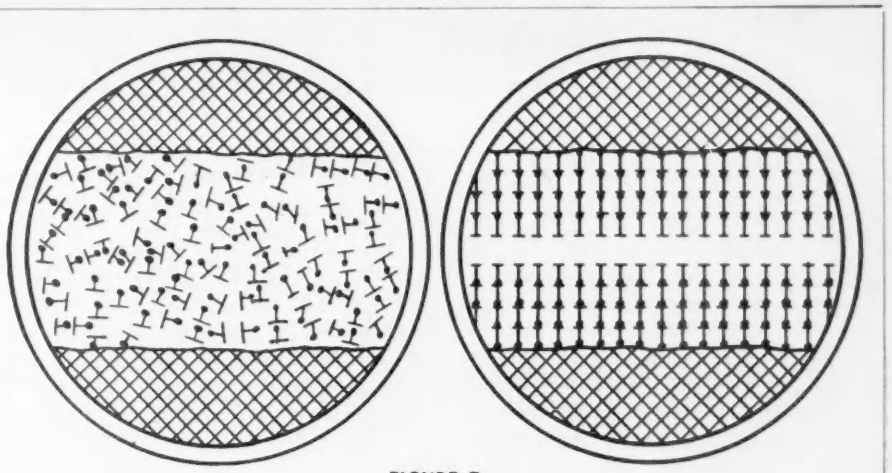


FIGURE 7

Left: Magnified conception of non-oriented oil molecules between surfaces. Right: Magnified conception of fully oriented oil molecules between surfaces.

Generally, the percentage of fuel dilution present in the lubricating oil is dependent upon operating conditions and, as a result, a variation in the percent of fuel present in the oil is experienced. Many engines, however, reach an equilibrium quickly and apparently the fuel dilution percentage neither increases nor decreases from a constant figure. It is evident that frequent changing of the lubricating oil alone cannot eliminate the factor of fuel dilution.

Lubricating oils containing suitable oxidation inhibitors and possessing detergent dispersant properties further provide a basis for extending the oil drain period. This is especially significant where the detergent dispersant properties are sufficient to hold colloidal solids in suspension so that they are returned to the combustion chamber for exhausting along with consumed lubricating oil.

There is no evidence that combustion chamber deposits are significantly increased even though the Conradson carbon residues of used oils containing detergent dispersant compounds show appreciable increases.

Conclusion

In concluding, it should be pointed out that the basic of all machine design and production is efficiency. The economic or cost factors are always a matter of prime consideration to the operator of combustion engines. Fuel costs, maintenance costs and the cost of lubricants are all significant items influencing the over-all efficiency of any combustion engine. If costs can be reduced in one phase without increasing costs at other points and horsepower output does not suffer, it appears that some progress, along the road to increased over-all efficiency, can be made.

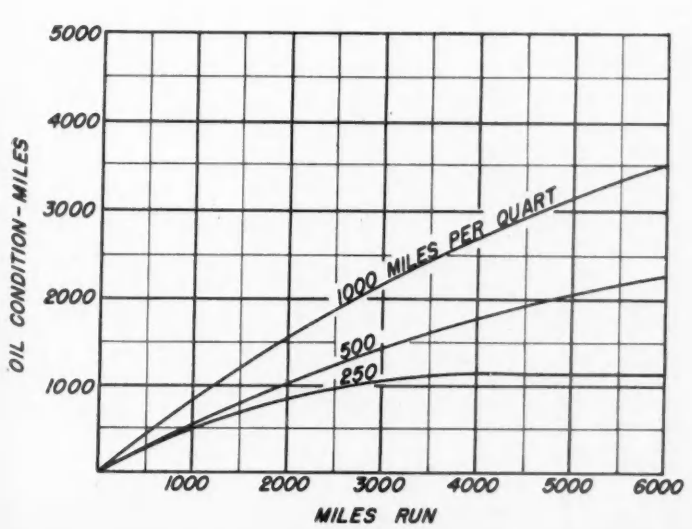


FIGURE 8

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"Problems in the Field of Internal Combustion Engine Lubrication." Professor C. Fayette Taylor, Massachusetts Institute of Technology, Cambridge, Massachusetts. Paper presented before the Institute of Mechanical Engineers, London, England, October 13-15, 1937.

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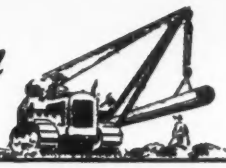
PIPE LINE *Construction*



A SLOWDOWN of activity became perceptible in January and early February, delays because of bad weather having been consistently reported from all sections of the country. The weather caused abnormal need for fuel supplies in industry and private homes. Many plants were shut down for lack of fuel. Some of the plants concerned were steel manufacturers, further decreasing the amount of steel pipe promised for line construction in the immediate future. Severe shortages of natural gas and fuel oil are still being experienced in the Eastern, Northern and Appalachian regions of the U. S.

Contract for another spread on the Basin Pipe Line System, being built by The Texas Pipe Line Company, Shell Pipe Line Corporation, Empire Pipe Line Company, and Sinclair Pipe Line Company was awarded to Morrison Brothers Construction Company. Latex Construction Company has completed approximately 60 miles of its 253-mile spread from Midland to Wichita Falls. The Texas Pipe Line Company expects to award contract on 80 miles of 26-inch crude line from Houston to the Port Neches refinery. Oklahoma Contracting Company is working on two spreads of the Magnolia Pipe Line Company's 20-inch crude carrier from Corsicana, East Texas, to Patoka, Ill., including 125 miles from Conway, Ark., to the Arkansas-Missouri state line and 119 miles from the Mississippi River to the state line, the latter being shut down until March 1 because of bad weather.

Pipe Line Construction Activity

COMPANY	Origin and Terminus	Length (Miles)	Pipe Size (Inches)	Daily Capacity (Bbls. Cu Ft.)	REMARKS
CRUDE OIL LINES					
Gulf Refining Co., Houston Pipe Line Division	Loop from Lucas to Port Arthur	11	10	.....	Latex Construction Co., Houston completed late January.
	Loops between Alameda and Raywood Stations	15	8	.....	Latex Construction Co. has started project.
Gulf Refining Co., Tulsa Pipe Line Division	Robinson, Illinois	20	10	.....	Sheehan Pipe Line Construction Co., Tulsa, completed.
Humble Pipe Line Co.	Hastings to Webster station, Upper Texas Coast	6 7/10	8	.....	Work will start by March 1 on dismantling of two 4-inch lines, to be replaced by 8-inch. Contract awarded shortly.
Interstate Oil Pipe Line Co.	Katie-Maysville, Oklahoma, area	7	12	.....	Extension of line from Oklahoma City trunk line started by Midwestern Engineers, Tulsa, in February.
Kaw Pipe Line Co.	Russell, Kansas, area	3	4	.....	R & G Pipeline & Construction Co., Russell, completing construction and reconditioning of 6-inch line.
Mid-Continent Pipe Line Co.	Moore, Oklahoma, west of Norman	7	6	.....	Pipe Line Service Co., Seminole, Oklahoma, completing.
Shell Pipe Line Corp.	Ellenburger discovery, P. B. Scott Survey, Upton County, to Upton station, West Texas	10	8	.....	Project completed by Morrison Brothers Construction Co., Odessa, Texas.
Skelly Oil Co.	Gathering line extension in Velma field, Stephens County, Oklahoma, to Velma station	9	6	8,000	Contract awarded to Bishop & Lock Construction Co., Dallas, work under way.
Stanolind Pipe Line Co.	Nelagoney junction to Hominy station, Oklahoma	12½	20	.....	Midwestern Constructors, Tulsa, scheduled to complete loop in March.
	Gathering system in Levelland field, Hockley County West Texas	10 16	6 4	.....	C. L. Rogers Construction Co., Wichita Falls, Texas, Completing.
Sun Pipe Line Co.	Garcia field, Starr County, to Ross field, Southwest Texas	11 4 1	4 6 8	.....	M. D. Altgelt Construction Co., Corpus Christi, Texas, completing gathering system.
	Canales field, Jim Wells County, to La Gloria field, Southwest Texas	2 11	4 6	.....	Shanks and Eustace, Alice, Texas, starting gathering system, scheduled for completion in March.
The Texas Pipe Line Co., Shell Pipe Line Corp., Empire Pipe Line Co., Sinclair Pipe Line Co. (Basin Pipe Line System)	Jal, New Mexico to Midland West Texas	92	20	.....	Construction for second spread of basin outlet scheduled to start late March, complete in June. Morrison Bros. Construction Co., Odessa, contractor.
PRODUCT LINES					
General Petroleum Corp.	Torrance refinery to Edison Company, Redondo Beach, California.	5	8	.....	Hood Construction Co., Lynwood, California, completed.
National Cooperative Refinery Association	Council Bluffs Iowa, to Great Lakes' system at Irvington, Nebraska	12	6	.....	Construction planned when steel available.
Sinclair Refining Co.	Arlington terminal of Gulf Coast line to Shawnee Okla.	180	8	.....	Contract awarded to Pacific Pipe Line & Engineers, Ltd., Los Angeles. Work under way.
Socony-Vacuum Oil Co.	South Portland to Bangor, Me	127	6	11,500	Right of way being cleared; construction expected to start in May.
Socony-Vacuum Oil Co., White Eagle Division	Stockton, Kansas, area	45	6	.....	Contract to be awarded after March 1.
NATURAL GAS LINES					
Carbide and Carbon Chemicals Corp.	Charleston to Shegon, West Virginia	55	10	.....	Pacific Pipe Line & Engineers, Ltd., completed in January.
Cumberland and Allegheny Gas Co.	Terra Alta, West Virginia, and Oakland, Maryland	7	6	.....	Obtained FPC authorization to construct
Dirreccion General del Gas del Estado	Buenos Aires to Comodoro Rividavia fields, Argentina	1040	10	.....	Contract for southern section of line awarded to Compania Tecnica International.
El Paso Natural Gas Co.	From main line to Phoenix, Arizona	20	8⅝	.....	Completed by company crews.
	Near Tuscon, Arizona	5	6⅝	.....	
		22	4½	.....	Scheduled completion April 1. Company crews.
	Eunice, New Mexico; to Dumas, Texas Panhandle	251	24	.....	Construction to start April 1. Company crews.
The Home Gas Co.	Hancock to Cochecton, New York	26	12	.....	Authorized by FPC.
	Horseheads and Dundee storage field, New York	25	10	.....	

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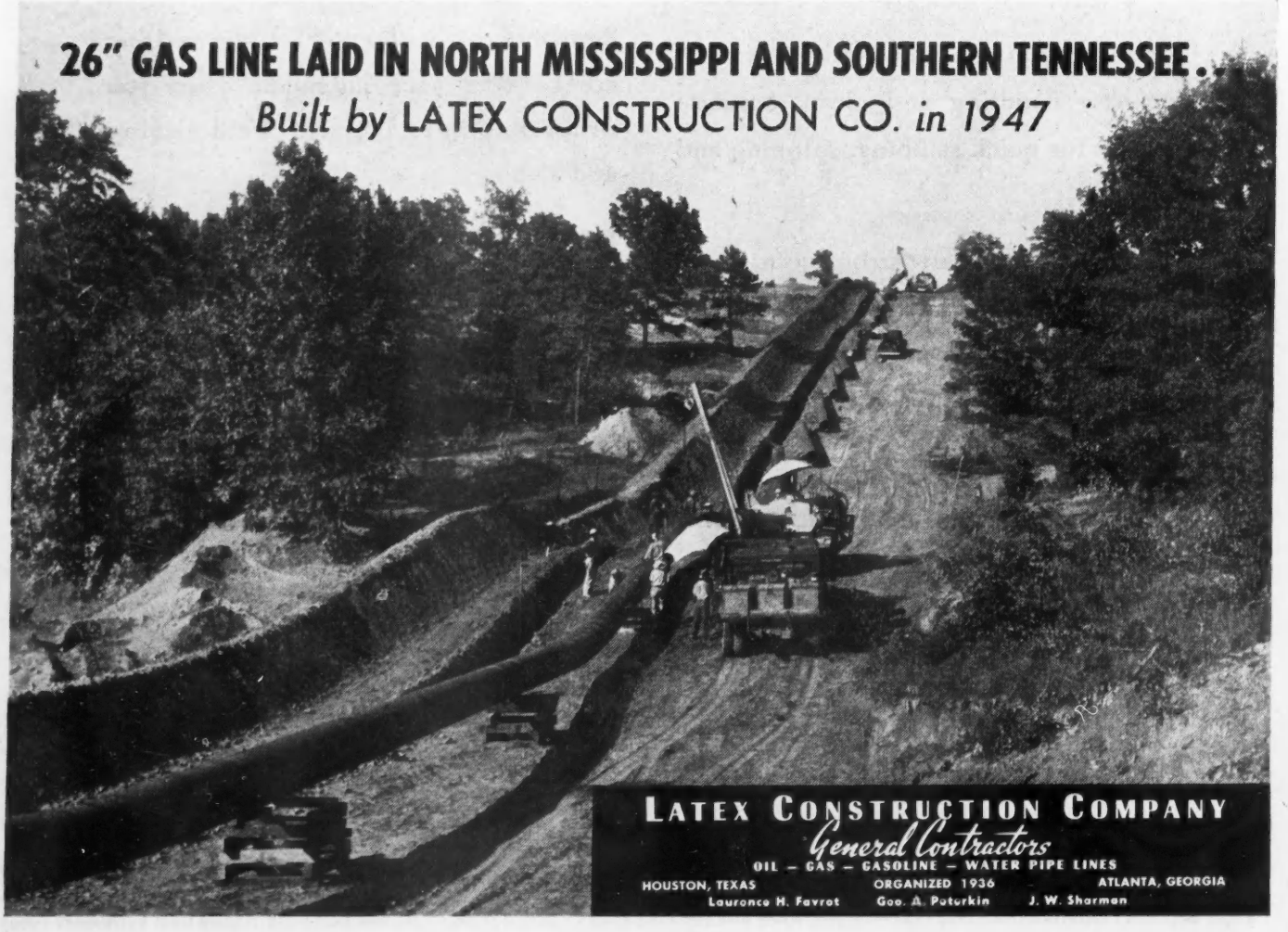
Pipe Line Construction Activity (Continued)

COMPANY	Origin and Terminus	Length (Miles)	Pipe Size (Inches)	Daily Capacity (Bbls., Cu. Ft.)	REMARKS
Independent Natural Gas Co.	Blue Lake field, Brazoria County, to Sweeney, Texas Gulf Coast	17½	8	30 mln	Associated Contractors & Engineers, Houston, to complete April 1.
Manufacturers Light and Heat Co.	Two connections to TET in Greene County, Pa.	1¼o	14	.....	FPC authorized also 1000-HP compressor station and TET connection in Chester County. Company later directed to establish connections with York County Gas Co. at 2 points near Shrewsbury and Manchester.
Michigan Gas Storage Co.	Compressor station 4000-HP, on Panhandle Eastern Pipe Line Co. line near Flint, Michigan	..	..	24 mln	Application to FPC for compressor station to increase capacity, since pipe for authorized line from Freedom Junction to storage field is unavailable.
Northern Natural Gas Co.	Connection with present line near Ames, Iowa, to Marshalltown area, extension to Colo and State Center	34	10	.....	FPC authorized construction.
Ohio Fuel Gas Co.	Rushland, Ashland, Knox Counties, Ohio gathering lines	3 3 3½ 2 10 8 11	3 4 6 8 10 12 16	.....	Contract let to Mahoney Contracting Co., Mt. Pleasant, Michigan: work starting February to complete in July.
	Ashland, Ohio	7 14	12 8	.....	Takeup and recondition job completed by Sheehan Pipe Line Construction Co.
	Lima, Ohio	8	12	.....	Construction completed by Sheehan Pipe Line Construction Co.
Pan American Gas Co.	Chocolate Bayou to Texas City, Texas Gulf Coast	18	16	140 mln	Contract awarded to Latex Construction Co., Houston. Work scheduled to start March 15.
Panhandle Eastern Pipe Line Co.	Hugoton field, Kansas	4⁹⁄₁₀ 1³⁄₁₀ 2⅕	26 10 8	.....	Project completed. The 26-inch line replaces a 16-inch.
Petroleos Mexicanos	Poza Rica field to Mexico City, Mexico	150	20	35 mln	Construction started by Williams Bros., Tulsa.
Tennessee Gas Transmission Co.	Main line loops and extensions	150 150	30	60 mln	Application to FPC in January.
	Loops on Texas-West Virginia line	524	20-26	.....	Contracts being awarded; approximately seven spreads.
United Gas Pipe Line Co.	Between Mobile, Alabama, and Pensacola, Florida	9	16	.....	Line replaces 12-inch pipe. B & M Construction Co., Okla City, Contractor.
Warren Petroleum Corp.	Gathering lines near Antioch and Maysville, Oklahoma	60	2-30	25 mln	Contract awarded to Holland Construction Co., Tulsa. Scheduled completion date April 1.


26" GAS LINE LAID IN NORTH MISSISSIPPI AND SOUTHERN TENNESSEE..
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LATEX CONSTRUCTION COMPANY
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ORGANIZED 1936
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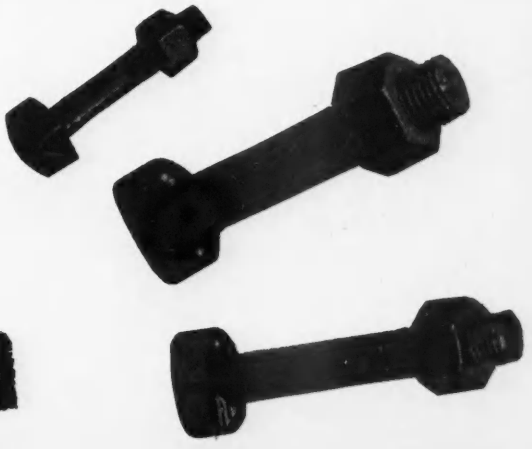
Rx *Cures joint troubles of pipe in Corrosive Service*

ACIPCO NI-RESIST BOLTS *resist* CORROSION *and* S-T-R-E-S-S



Assorted tee head and square head, standard size Ni-Resist bolts. Ni-Resist bolts are now standard equipment on Double Simplex lock joint and Molox ball and socket joint pipe for submarine installations produced by American Cast Iron Pipe Co.

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Moreover, a ¾ inch Ni-Resist bolt of this type will take a cold bend of 30 degrees around a 1 inch diameter pin without cracking.

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Bolt Material	Per Cent Loss in Wt. of Bolts
Plain Cast Iron	26.9
Pearlitic Malleable	24.0
Ni-Resist	0.6
Bronze	0.0

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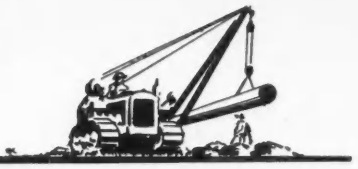
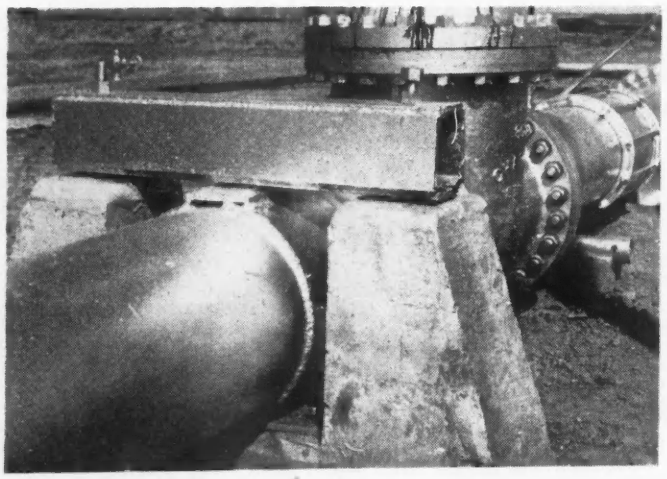
How to do it!

PIPE LINE HINTS



$10 is paid for each illustrated acceptable contribution. Mail to The Editor, WORLD OIL, P. O. Box 2608, Houston 1, Texas

How To—Confine Movement of Line Due to Temperature Changes

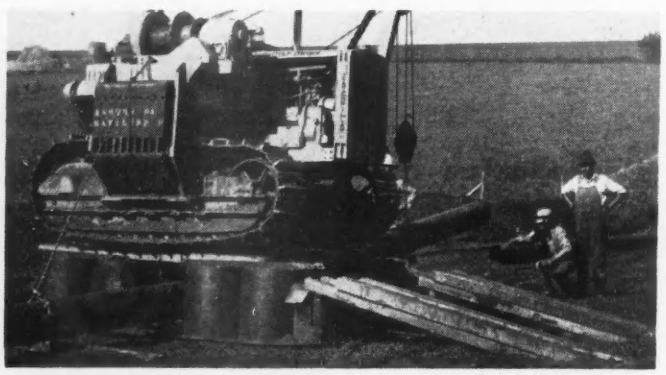


In order to eliminate possibility of developing leaks in the line at points where it must be confined to relatively narrow limits of movement brought about by expansion and contraction due to temperature variations, one company employs several practical safeguards.

Surrounding the pipe at the point where it is confined between the side members of a U-shaped concrete guide and support, is a sheath of ½-inch steel plate which is welded directly to the pipe. At the top and bottom, small rectangular scuff pads of similar plate are welded, the latter taking up the wear on both top and bottom of the line when movement of the line occurs. The line rests upon a wide steel plate bolted to the bottom of the concrete base, and at the top, should the line be buckled upward more than a quarter of an inch or more, it will contact a box-like confining member spanning the concrete piers.

This upper guard, consisting of two pieces of channel iron and two strips of steel plate welded together, forms a relatively light but very strong structural member. In this particular region, variations between day and night temperatures often are relatively severe, making it necessary that exposed portions of the pipeline be permitted to shift slightly without danger of rupturing valves and by-pass line connections.

How To—Simplify Bending Pipe in the Field with Available Power

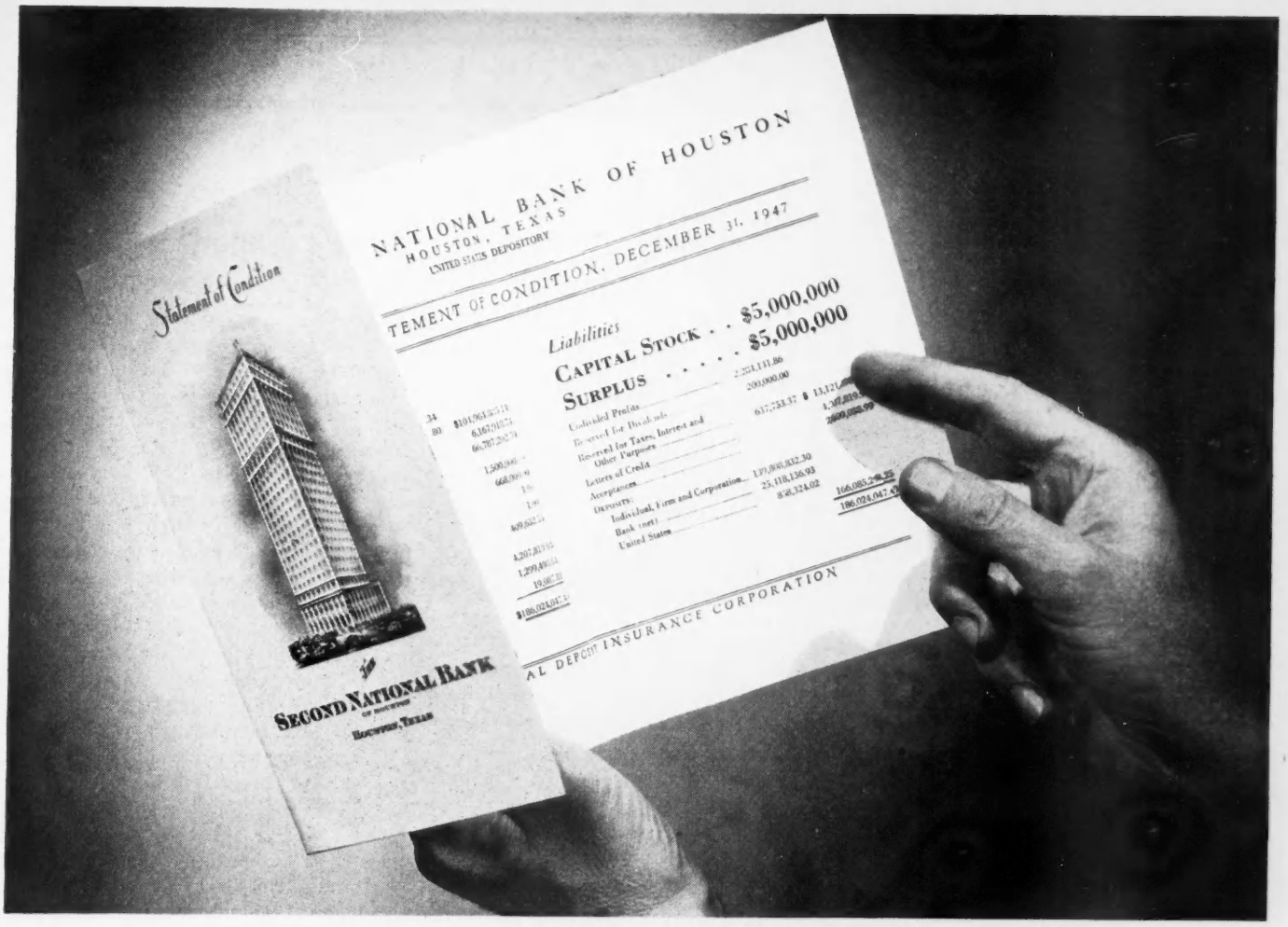


Bending relatively large-diameter line pipe in the field has always posed a problem. The pipe had to be curved to fit either the contour of the ground, or to make surface bends to conform with right-of-way. Eliminating much of the extra equipment normally required in pipe bending operations, one Kansas pipe line contractor employed a tractor with a side boom and an all-steel platform to make slight bends in line pipe.

The method of bending pipe as illustrated consists of elevating the tractor, anchoring one side to the pipe and attaching the winch line through a pulley system on the side boom and to the other end of the pipe. The winch line was drawn up tight to provide the necessary force required to make the bend. The pipe may be preheated with an acetylene torch, or in the case of 12-inch pipe and smaller, slight bends may be made satisfactorily when cold.

The platform structure was made from four short nipples of 24-inch pipe, each piece approximately two feet long. These were welded as shown to strips of ½-inch steel plate 24 inches wide, thereby making two separate sections, one for each track of the tractor. Across the top of the structure was welded a section of wide channel iron on which timber could be laid to protect the lugs on the tractor. To the front end on each side of the device was added short nipples of 12-inch pipe. These provided a rest on which wooden ramps could be placed.

By making each half of the supporting device separate, the unit could be used with any tractor of any track width. The operator drove the tractor up the ramp and onto the platform after the pipe had been laid in place between the rows of 24-inch uprights. The unit is portable and will accommodate any size tractor of sufficient power to make a pipe bend.



EXAMINE THESE FIGURES

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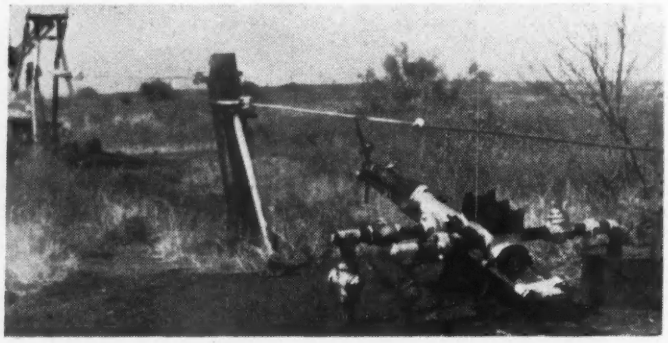
How To—

Mount Pump for Rod Line Power Take-off



Excellent use can be made of rod line reciprocating motion for the operation of a pipe line pump by installing the unit in the tilted position similar to that shown in the photograph. The single cylinder pump was mounted directly beneath the rod line at a distance of eight to ten feet from a heavy rocker post. A 2½-inch pipe connecting arm transmits motion from this arm to the pump piston. Tilting the pump at the slight angle does not affect efficiency of the pump, and it assures a nearly direct in-line motion between the post and pump.

Much depends upon where the pipe line lies in respect to the wells on the lease, but it is advisable, where possible, to locate the pump at a point where the pump stroke may help to serve as a counterweight in the centrally pumped system. If this is not possible, the installation of a stone box or other counterbalancing measure, if needed, will be comparatively simple. The connecting arm may be disconnected easily merely by removal of a steel pin joining the matching links.

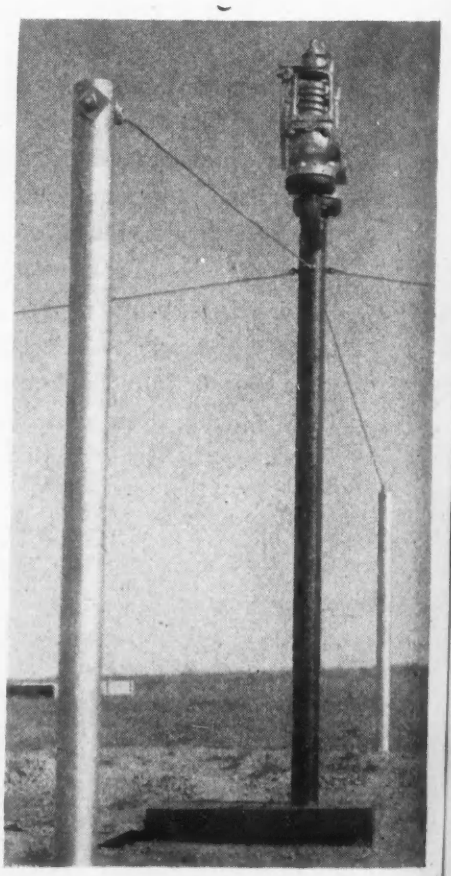
How To—

Anchor Pop-off Line

Adequate protection of high-pressure compressors in gas systems can be provided by including in the high-pressure discharge line safety pop-off valves which release excessive pressures in case the downstream line is suddenly or accidentally shut off. On one gas line which was buried several feet below the ground level, a hydraulic tee brought up such a pressure release line above the surface where two safety pop valves were installed.

To properly vent the volume of gas which would keep line pressure within safe limits when the compressor continued operating against a closed discharge line, two safety pop valves were used. They were carried on a three-inch riser connected to the high-pressure gas line. At the upper end of this riser was added a tee to which was connected two spring-loaded pop valves.

Because the discharge from the safety valves was 90 degrees to the riser, additional support had to be incorporated in the pressure release system. This additional bracing was provided by four guy wires attached to eyes welded to



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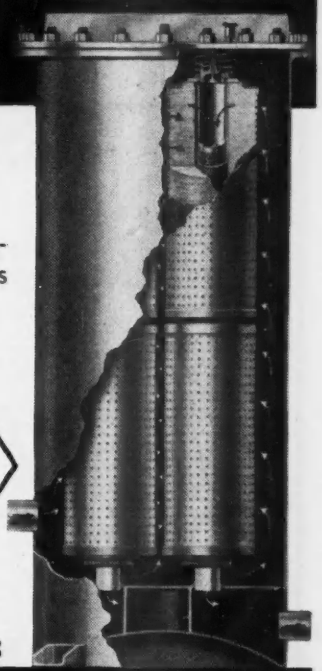

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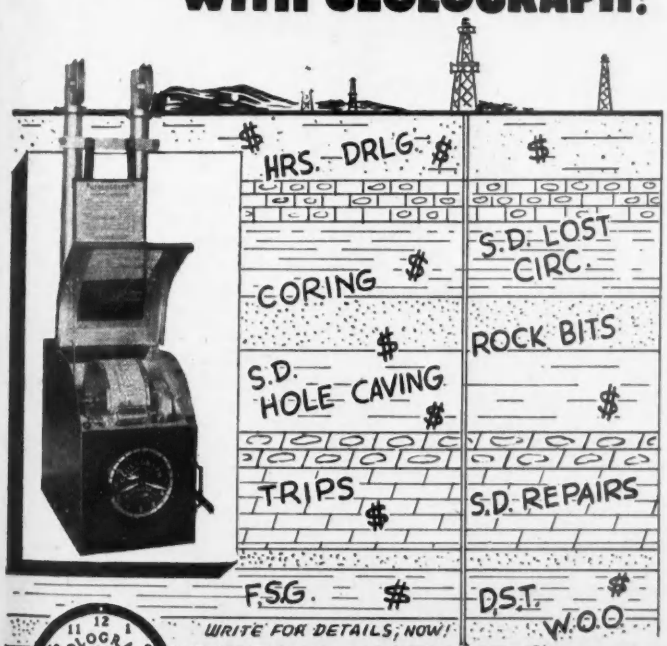

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ALUMINUM FRONT-END WINCH

For Jeep Vehicles, Passenger Cars, and Pickups

The New Ramsey Model 101 Aluminum Front-end Winch has the following outstanding features:

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2. Since special mounting frames are furnished to fit each vehicle, installation can be accomplished by any good garage in from 4 to 8 hours, depending on the vehicle.

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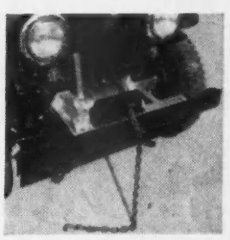

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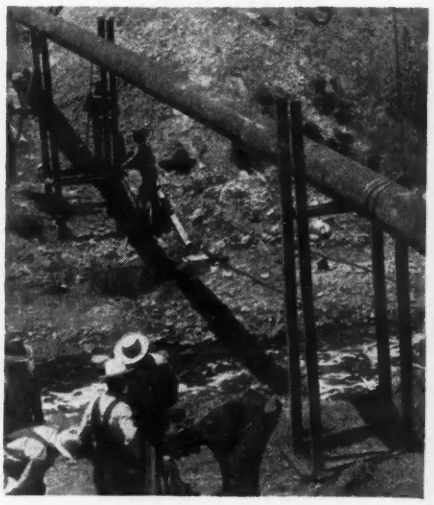
IF YOUR DEALER CANNOT SUPPLY YOU WRITE TO CARL POOL MFG. CO., SAN ANTONIO

the three-inch riser. The wires were guyed to eight feet sections of three-inch pipe, three feet of which were set in concrete to form a rigid footing. Top of the exposed five feet was drilled and an eye bolt inserted with the eye directed towards the gas line riser. The lines were drawn tight and could be maintained in this position by screwing up on the eye bolt. The guy wires supported the pressure-release vent when the pop valves opened, thereby preventing undue stress on the welded connection to the main line.

How To—Support Pipe Line at Stream Crossing



In some cases it is more desirable to support a pipe line above a stream rather than attempt to bury it below the creek bed. Not only does such practice reduce cost of laying the line, but the future danger of corrosion is reduced at this point.

Illustrated is a 20-inch gas line spanning a creek bed at a height never reached by the water in the stream. Two simple supports, one on either side of the creek, provide the necessary structure to reduce the stresses in the line. These supports are welded structures of steel railroad track that had been discarded by a nearby railroad. Because of the rocky terrain, it was not necessary to pour a concrete foundation for the supports.

A rectangular box, about three feet by four feet, was made by welding the pieces of track to form the base. To the inside corners of this base, the four upright members were welded. The pipe line was allowed to rest on two similar cross members welded to the uprights which were cross-braced at line level. Weight of the pipe on the supporting structures was sufficient to prevent them from shifting. Side boom cats were used to lift the line prior to welding the top cross members, and thereby taking much of the weight of the pipe.

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GOTT Water Cans are the practical way to keep drinking water cool for long periods, protected from impurities and always handy to the job. Snug fitting large removable top, strongly built to withstand rough usage. GOTT Water Coolers have extra large covers and a handy non-leaking push button faucet. Your Supply Store has them, get one today! . . . . . .

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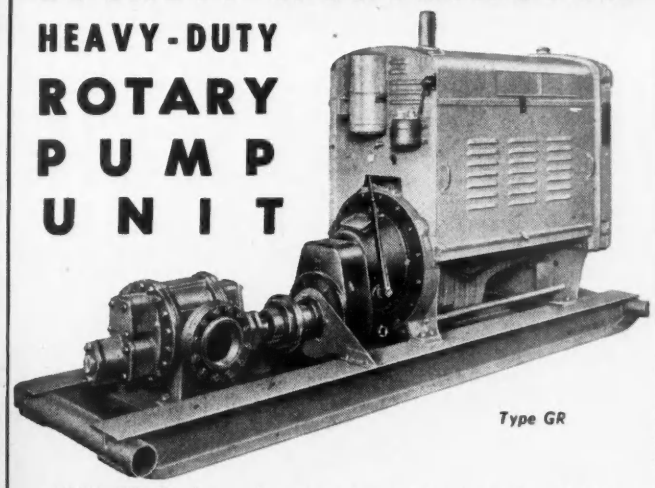

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4-wheel Nos. 42 & 44 for fast quarter-turn cutting.

RIDGID WORK-SAVER PIPE TOOLS

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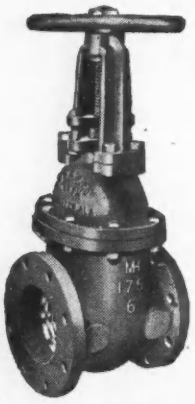
"Red Wheel"
VALVES, HYDRANTS
And Pipe Line Accessories



M & H valves are used in the oil industry for water, gas, steam, oil, chemicals and are furnished in all commercial sizes from 2" to 30", inclusive. They are cast iron body, bronze mounted, furnished double disc parallel seat or solid wedge. They are heavily proportioned and have a high factor of safety.

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SPECIAL TRAFFIC MODEL is designed to yield at ground line under impact, repair being simply renewal of breakable bolts and breakable coupling on stem. High efficiency because barrel diameter not reduced and there are no working parts or obstructions in waterway.

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M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA

PIPE LINE HINTS

How To—

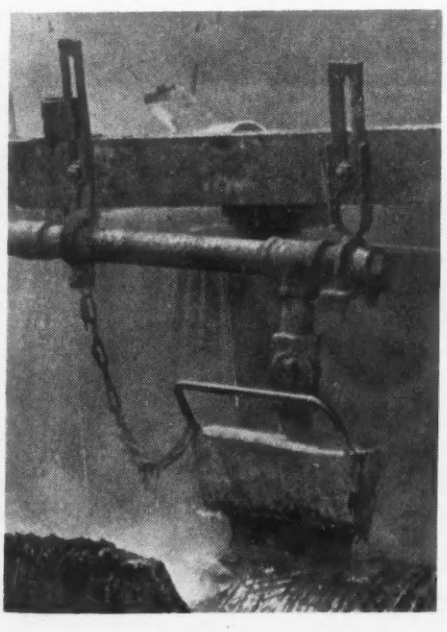
Adjust Tar Applicator

With new line pipe practically unobtainable these days, pipe reconditioning plants are working overtime cleaning and rewrapping used pipe. Normally, the pipe coating and wrapping machine is modified to suit the immediate needs of the job at hand. In many cases, pipe wrapping machines consist of manufactured parts plus considerable adaptation of other parts by the user.

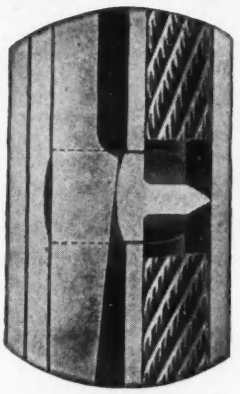
A special feature of one such pipe wrapping machine is a simple device which permits the operator to raise and lower the triangular tar applicator easily as the size of pipe being handled is changed. This makes it possible to control the flow of hot tar over the rotating pipe.

A section of light-weight channel iron is supported over and parallel to the pipe being wrapped, as illustrated. From this member is suspended the hot tar feed line which can be adjusted by simply loosening two bolts holding the supporting pieces. These pieces are merely slotted strap steel that are attached to the tar feed line by a U-bolt and a clamp. The slotted member permits the support to be raised or lowered.

When it is necessary to change size of pipe being wrapped, only a few minutes are required to readjust the height of the tar applicator for best coating operations. The device is simple and inexpensive, and provides an adjustment which can be made while the tar continues to flow through the machine.



IF you ever need to get loose from a STUCK SAND LINE,
IT CAN BE DONE
with the KINLEY
SAND LINE CUTTING TOOL



Cuts any size wire line up to 11/16" in any size pipe as small as 2" tubing. It cuts the stuck line at the top of the rope socket, thus saving the line as well as the cost of a fishing job.

Complete details will gladly be sent on request.

Write or Telephone for Complete Details

Enlarged drawing of section of tool inside tubing, showing tapered wedge forcing knife thru wire line.

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Heat Treated • 5 Sizes
With New, Improved, Reinforced Non-Spreading Mouth

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		1 Swivel	Wt. Each
MIDGET	No. 1—	¼" chain	2¼ lbs.
DELTA	No. 1—	5/16 or ⅜" chain	6½ lbs.
		Two Swivels	Wt. Each
DIXIE	No. 1—	7/16 or ½" chain	10 lbs.
LONE STAR	1—	7/16, ½ or 5/8" chain	14 lbs.
LONE STAR	2—	7/16, ½ or 5/8" chain	17 lbs.

LOAD BINDER — DROP-FORGED
Heat Treated • 2 Sizes

Two Swivels
Durbin-Boomer F-1—for ⅜", chain . . . . . 10 lbs.
Durbin-Boomer F-2—7/16, ½ or 5/8" chain . 12 lbs.

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COMBINATION ROPE HOIST AND WIRE STRETCHER • Extra Heavy Duty
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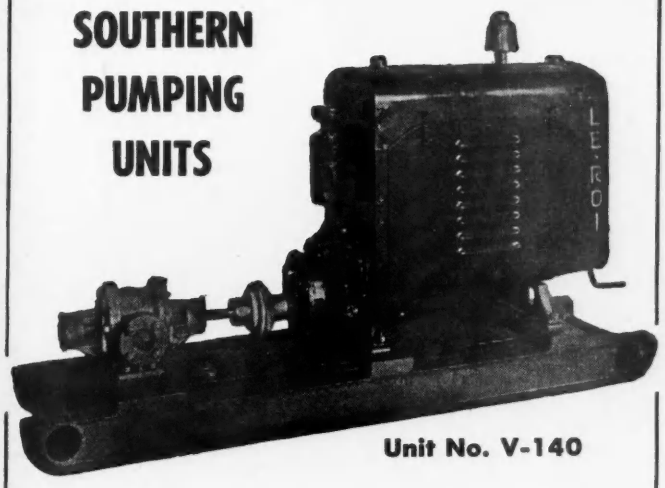
SOUTHERN PUMPING UNITS



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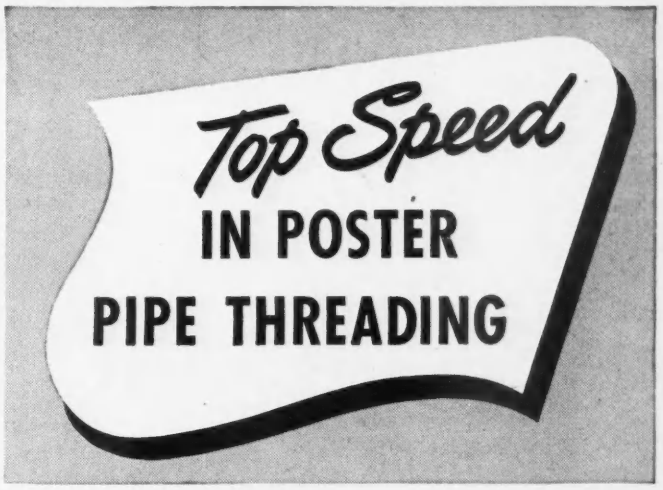
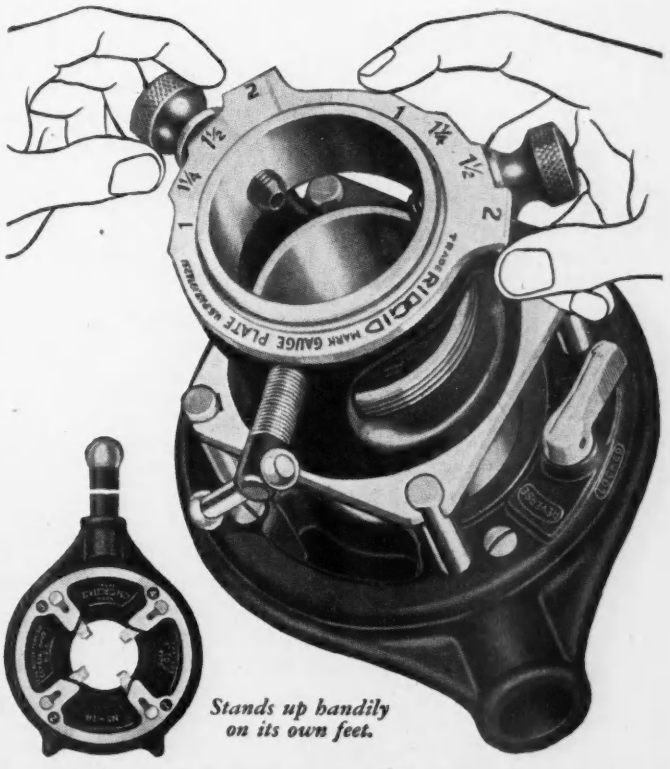


Extra fast get-ready with this No. 1R RIDGID Threader for 1" to 2" pipe

● If you're partial to poster die stocks . . . here's the one you want. Changing dies is fast as any, but mistake-proof workholder sets faster — only one screw to tighten on pipe, no bushings to monkey with. You'll like the direct-action threading, too — straight line . . . handle to head to dies . . . no wabble. Sets of 4 precision chasers, 1" to 2." Popular price — buy at your Supply House.



Stands up handily on its own feet.

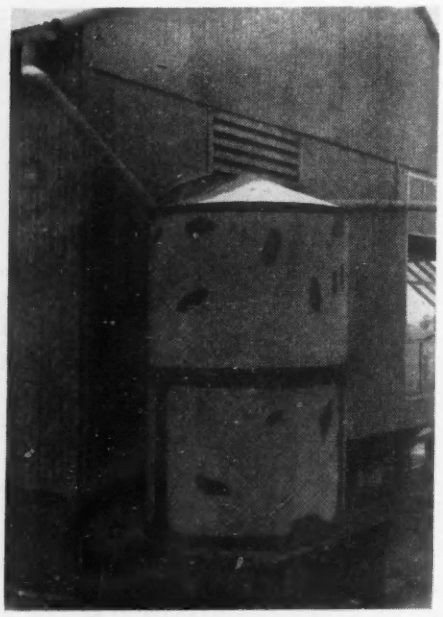
RIDGID

WORK-SAVER PIPE TOOLS

THE RIDGE TOOL COMPANY • ELYRIA, OHIO

How To—

Collect Cooling Water



Where small pipe line pumping stations are located on remote leases, supplying fresh water for cooling the engine radiator is a problem. Water must be added periodically to the radiator to replenish that which is lost due to evaporation or leakage.

To eliminate the chore of carrying fresh water to the station for this purpose, one company installed a water collecting system as shown. Galvanized gutters and downspouts are constructed on the station building, with three-inch galvanized pipe from both gutters terminating in a 50-barrel galvanized water tank. Water collected on the roof during rains is caught in the gutters and directed through the downspouts to the water storage tank. The fresh water is stored here until needed in the cooling radiator.

A one-inch line is tapped near the bottom of the tank and leads inside the building where a faucet terminates the line. It is convenient for the operator to fill a bucket with water from the faucet and add the water to the cooling system. Uncontaminated water is thus assured, reducing corrosion in the cooling system to a minimum. The idea has been used for many years by the farmer and rancher, and in the case described, has been of considerable value to the pipe liner.

How To—

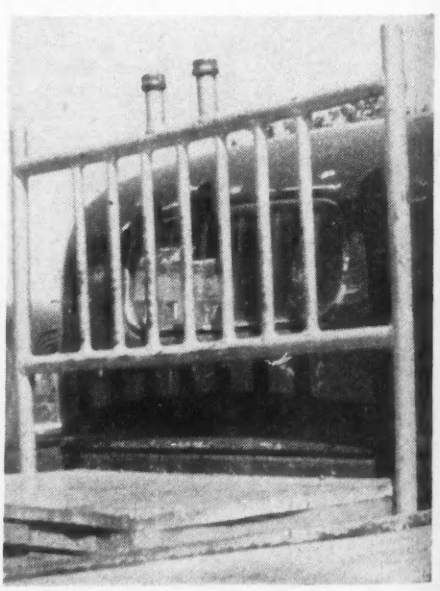
Protect Truck Cabs

Protection of truck cabs against shifting loads and loading operations was afforded by one pipe line operating company that devised a sturdy grill which was mounted directly behind the cab of each truck.

The end up-rights and the horizontal cross members are pieces of 1¼-inch pipe welded together to form a rectangular frame. Holes were cut in the upper slanting edges of the truck box, to permit the passage of the lower end of the upright legs. The bottom end of each leg was welded to the frame of the truck below the floor of the truck box, thereby insuring rigidity.

The vertical bars forming the grill directly behind the glass in the cab, are short pieces of ¾-inch pipe which are spaced four inches apart. The ends of each is securely welded in place between the horizontal members of the rectangular frame made of 1¼-inch pipe.

Aside from being a protective device for the cab glass, the upward projecting of the end members of the rectangular frame plus the two capped pipe nipples which are welded to the upper horizontal member of the rectangular frame, serve as convenient projections upon which to hang muddy tire chains for drying, or any other pieces of supplementary equipment, such as rope or welding hose.



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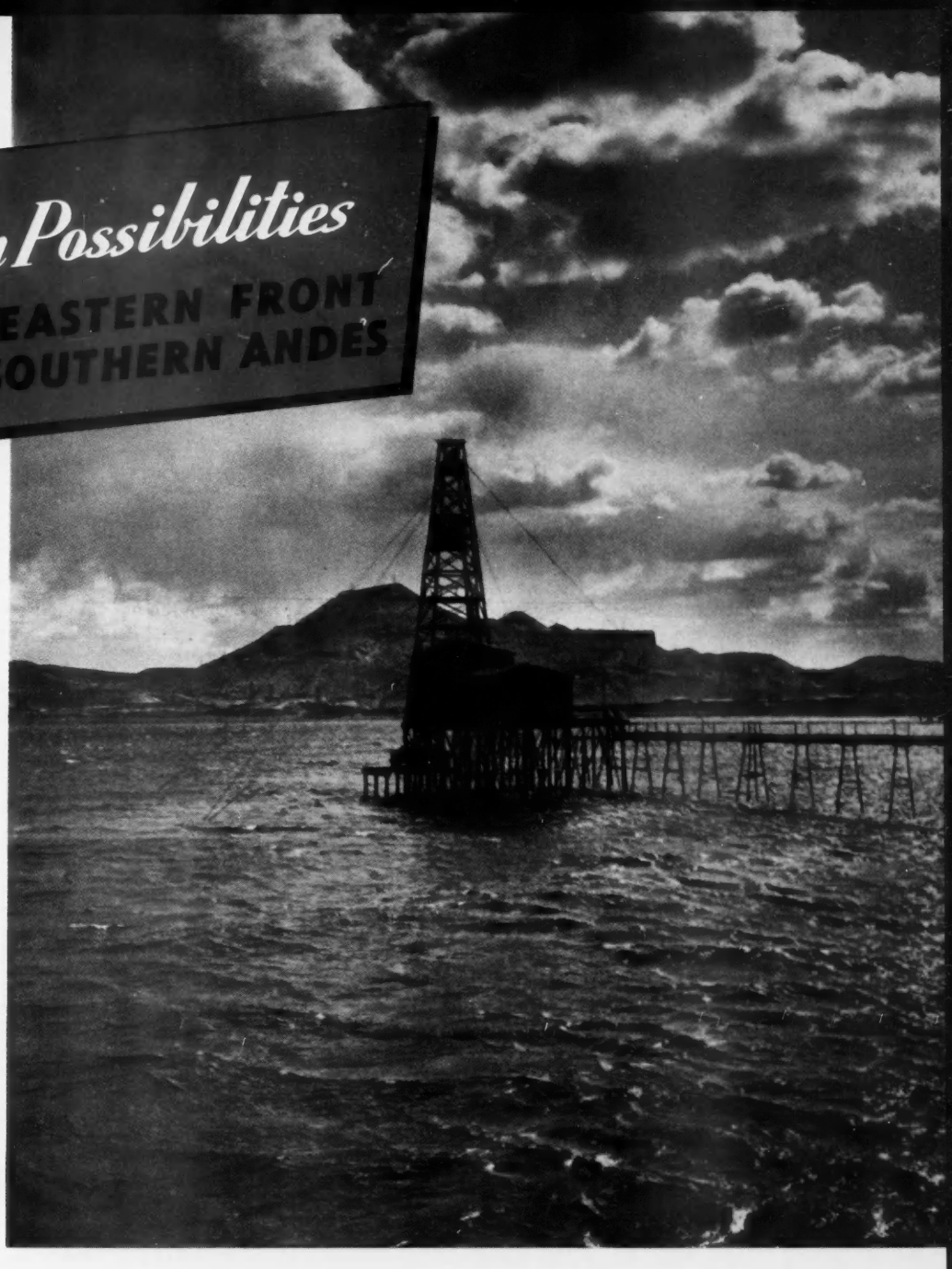
Petroleum Possibilities Along EASTERN FRONT of the SOUTHERN ANDES



By GLEN M. RUBY
Vice President
Hoover, Curtice and Ruby

THERE is a distinct break in the geography and geology of the Andes in the vicinity of the city of Mendoza, more or less along the 32nd parallel of south latitude. This is the point where the older ranges of the interior of Argentina, which have a northwesterly trend, are intersected by the younger and more vigorous mountain building movements of the Cordillera. North of this point the Andean belt is much wider and has not only a different pattern of folding, but a different type of sediments is also involved.

In the south the mountain chain is narrower and cuts indiscriminately across basins as well as "mazisos," the positive elements which acted as buttresses for the folding which has attracted petroleum prospecting.

The accompanying map shows the general features of this area, about 1600 miles long and extending from the Tupungato field in Argentina to the Spring Hill field in the Chilean portion of Tierra del Fuego. Four distinctly different oil producing basins are known to exist within the area.

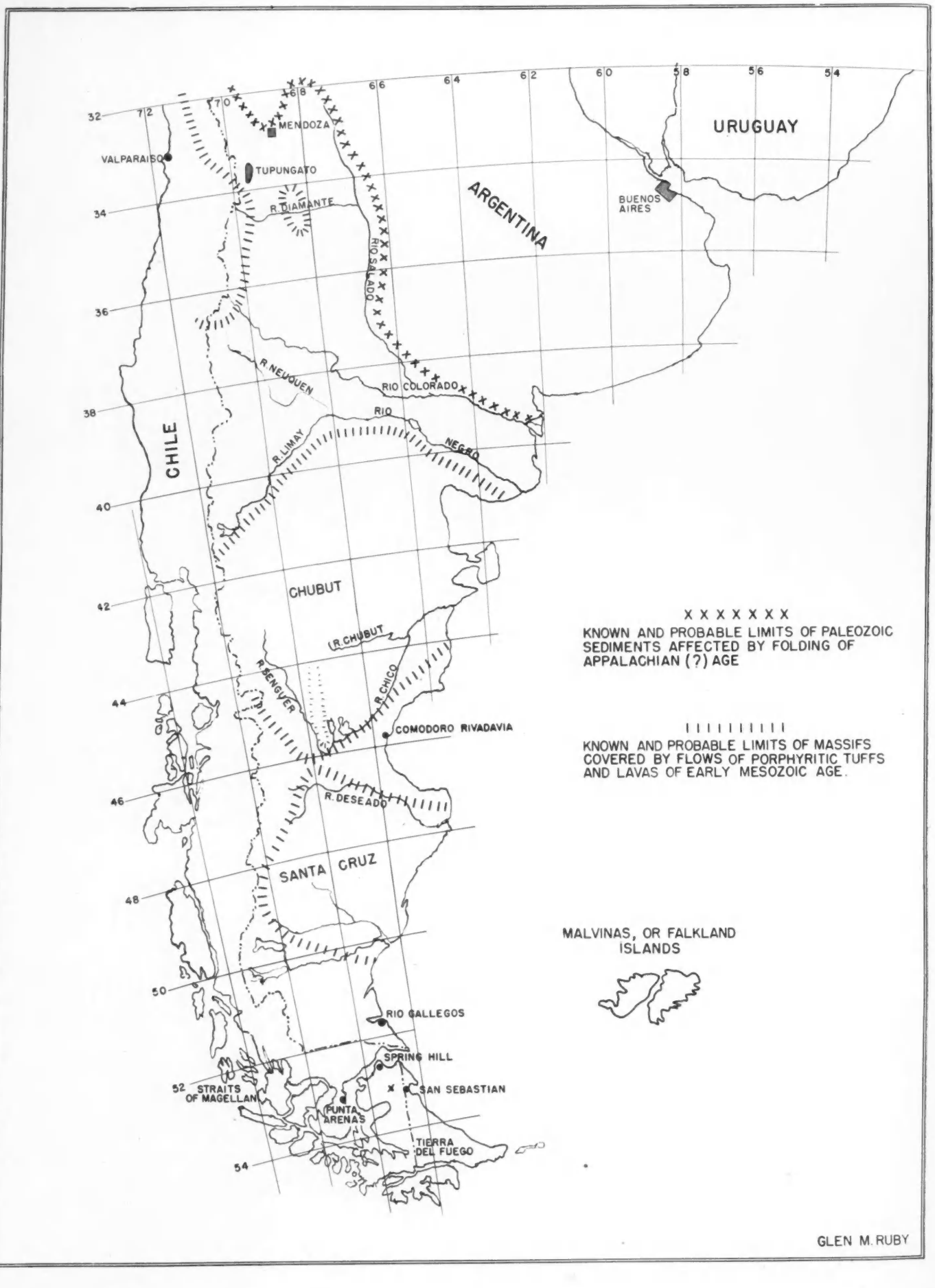
Since the readers of WORLD OIL are more interested in the search for petroleum than in paleontology, for example, this article will attempt to describe the region with special emphasis on petroleum geology.

Lost Continent

It is not profitable to the petroleum geologist to spend time in speculating on just why the Cordillera chose to make a cut "on the bias" across previously established structural elements. Neither is it possible for him to reconstruct the paleogeography of the area to the west, now buried under the Pacific. Undoubtedly there was a large land mass there, and between it and the area we know as Patagonia, there was a large, probably irregular, basin filled with an almost complete section of Mesozoic sediments.

However, the movements which resulted in the Andes caused this old continent to disappear, and all that is left of the intermediate basin are the fragments which were in the embayments between the massifs, as indicated on the accompanying map. There were four positive elements lying to the east of this huge Mesozoic basin, the basin which vanished from sight with the advent of the Andes. The largest element was not a part of the chain of porphyry-covered islands. It was more in the nature of a continent, and took in Brazil, Uruguay and Argentina, as far south as 40 south latitude and west to Rio Salado.

The chain of "islands" or "massifs" extended from south latitude 50 to be-


MENDOZA
VALPARAISO
TUPUNGATO
R. DIAMANTE
RIO SALADO
ARGENTINA
URUGUAY
BUENOS AIRES
CHILE
R. NEUQUEN
RIO COLORADO
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R. DESEADO
SANTA CRUZ
RIO GALLEGOS
SPRING HILL
STRAITS OF MAGELLAN
SAN SEBASTIAN
PUNTA ARENAS
TIERRA DEL FUEGO
32
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KNOWN AND PROBABLE LIMITS OF PALEOZOIC SEDIMENTS AFFECTED BY FOLDING OF APPALACHIAN (?) AGE
KNOWN AND PROBABLE LIMITS OF MASSIFS COVERED BY FLOWS OF PORPHYRITIC TUFFS AND LAVAS OF EARLY MESOZOIC AGE.
MALVINAS, OR FALKLAND ISLANDS
GLEN M. RUBY

Part of Comodoro Rivadavia field.

yond latitude 32. The northernmost, in fact, may have been only a porphyry-covered peninsula of the main continent, which sheltered a bay in its south and east side, where the Tupungato oil field now exists.

This basin (Mendoza) is the northernmost of the Patagonian embayments and was the first to produce oil. The old shallow field, at Cacheuta, was famous for many years for its large oil seeps, and several flowing wells were drilled into sand lenses, downdip and northward from the outcropping oil-saturated sand of Rhaetic age. This is a combination of structural and stratigraphic trap. How much the ancient fold has been deformed by later Andean movements is not known, but it is certainly a very old anticline with a granite core. This granite has been mapped as a Triassic intrusive, but the writer believes it to be pre-Cambrian since there is no contact metamorphism to indicate that it is intrusive. In fact, the writer believes all of this type of "pink" granite, which may be found south of the latitude of Antofasta, to be pre-Cambrian.

On the other hand, the grano-diorite seems everywhere to be an intrusive and to have occasioned a marked degree of metamorphism in the adjacent sediments.

South of the Cacheuta field the sediments thicken rapidly, and the next oil field, Tupungato, which is on the same general uplift, has several hundred meters of Jurassic (?) tuff overlying the black, Rhaetic shales. This tuff, which is known as the "Victor" beds, is not present on the main part of the Cacheuta field. However, in Tupungato, it is the principal oil-bearing formation, the oil finding storage in the cracks and fissures of the tuff, as well as some strata of sand intercalated in the tuff.

A large, well-defined dome, in Tertiary beds, still south of Tupungato, was drilled, but not sufficiently deep to penetrate a stratum of "porphyry" which was encountered. It is probable that oil-bearing sediments exist below this stratum, since it is of tufaceous origin and is not a true lava. On the other hand, there is a probability that the dome is of recent (Andean) origin and not oil-bearing.

East of Tupungato, about longitude 68, is another line of folding (Lunlunta) which is also oil-bearing.

Northeast of Mendoza is a small area underlain by Rhaetic beds, and it is probable that it may contain one or more oil fields, but it can be said very definitely that this general area marks the point where the old Appalachian intercepts the north-south trend of the Andes and there is a complete change (to the north) in the geology.

Highest Peak

Aside from petroleum there is another interesting feature in this same area. Mt. Aconcagua, on the International Border, just west of Mendoza, is the highest peak in the Western Hemisphere. It is 22,830 feet high and composed of late Tertiary sands and volcanic ash. It is not a volcano but is caused by enormous over-thrust faults, apparently coming out of a trough just off the coast, which has a depth, opposite Aconcagua, of 20,000 feet.

South of the Mendoza area is an anticline of mountainous proportions known as Sierra Pintada. It is composed principally of porphyry and, perhaps, like Aconcagua, caused by the "squeeze" between the old continent and the northernmost of the "massifs."

There is a large area, not yet adequately prospected, south of Rio Diamante and north of Rio Colorado. Along the headwaters of Rio Grande, the north tributary of Rio Colorado, is a series of folds in which are involved upper Jurassic shales and gypsum beds of Oxfordian age. They rest on the "serie porfirica."

Surface oil indications suggest that the upper Jurassic and Lower Cretaceous shales are oil-bearing, but there is a paucity of sandstones and other possible reservoir rocks. To the east of this area is a disturbed belt in which faulting places the porphyritic series in contact with the Upper-Cretaceous red beds, or continental, series. A well drilled several years ago by the Argen-

tine Government Oil Fields, and located near a seepage along this fault, found encouraging shows of oil in the red beds. It is probable that the porphyritic series here covers oil-bearing Rhaetic sediments. Between the above-mentioned faulted zone and Rio Salado is a salt and sand flat that is only broken by the uplift of Cerro Nevado, an igneous mass which also includes the tuffs of the porphyritic series. It is probable that a favorable sedimentary section underlies most of the flat surface surrounding this mountain, especially west and south of it.

Extending southward from this area to Rio Neuquen and Rio Negro is a large sedimentary basin of unknown depth. It is covered by flat-lying beds of late upper-Cretaceous age which were deposited from the Atlantic side of the continent. The same sea that entered the basin surrounding Comodoro Rivadavia also entered the trough between the Chubut massif and the old continent just northeast of it and reached to the present foothills of the Andes. It is only very slightly folded in the plains region but undoubtedly covers pre-Cretaceous folding.

Several large structures both north and south of Rio Colorado have been mapped in the older beds but, to the best of the writer's knowledge, have not yet been drilled because, no doubt, of the complete lack of roads and bridges. Until some drilling has been done, it will be impossible to know the extent of this basin, but it is probable that it is a part of the large embayment which is well known, between Rio Neuquen and Rio Limay, and in which the oil district of Plaza Huincul is located.

Source Beds

None of the "serie porfirica" is known in this basin. the apparent source beds are the shales of late Upper Jurassic age, (Tithonian), and the reservoir beds are the sandstones of the underlying Dogger, of middle Jurassic age. There is a marked angular and erosional inconformity in many places between the Dogger and the Tithonian which makes prospecting very difficult. Several structures have been drilled along the foothills, but in each case their north-south alignment indicates that they are very recent folds and were not formed prior to the Andean orogeny which no doubt explains, in part, the failure to find oil. Farther east, where Andean influence is not so marked, it may be seen that the tendency of pre-Andean folding was more along east-west lines.

While several oil fields have already been developed in this basin, the writer believes that it still offers more possibilities for future discoveries than any other part of Argentina. The geology is not simple, being complicated by at least four major unconformities, but the presence of source beds and timely folding, as well as proper conditions for stratigraphic traps, make it attractive for further prospecting.

The south side of this basin extends at least a short distance to the south of Rio Limay and the upper, east-west portion to Rio Negro. The southern limit of the Jurassic beds is masked by the overlap of a thick continental deposit of Upper Cretaceous age and composed of shales and coarse sandstones of various hues of red and purple. A few fragments of dinosaur bones are occasionally found. This has given these beds the local Argentine name of "Estratos con Dinosaurias," and has also contributed to the confusion of the stratigraphy in the Comodoro Rivadavia district.

Unlikely Area

Only in the extreme southwest of the basin do the Jurassic sediments reach south of the 40th parallel of south latitude. Elsewhere, at this latitude, the "Estratos con Dinosaurias" are seen to lie directly on metamorphosed Paleozoics and tuffs of the early Jurassic porphyritic series, which compose the "massif of Chubut." At no place, to the west of this massif, and in the ranges of the Andes, is it likely that any oil fields will be found.

The western edge of this massif has been folded, both by Andean movements and earlier compressive forces. Just where its southern limit lies is not clear, and the Atlantic Ocean hides its eastern limit.

Somewhere near the present course of the Rio Senguer, possibly a few miles to the west of it, there was a divide between the Atlantic and Pacific Oceans in Lower and Upper Cretaceous time.

Soon after the outpouring of the Jurassic porphyritic tuffs which filled in all of the topographic lows and in places exceeded thicknesses of 10,000 feet, there was an arching of the earth's crust in the present valley between the Cordillera and the range just east of the Rio Senguer, known as Sierra San Bernardino. While the area is now completely covered by a recent deposit of gravel and clay, it is possible that the large anticline to the north of Rio Senguer, near Nueva Lubecka, marks the approximate axis. At this point, also, may be seen the tuff series interbedded in what fossil evidence indicates to be shales of Jurassic age. It is probable that continued folding of this anticline exposed the relatively soft shales to erosion and resulted in the present wide north-south valley which now lies east of the Andes and which rivers now run across, from west to east.

To the west of this line, in the vicinity of Lago Fontana, may be seen a great thickness of Lower Cretaceous shale, Neocomian, resting on the eroded tuffs of the lower part of the porphyritic series with considerable angular discordance. The nature of these shales indicates that they were deposited from the west. To the east of this divide is no record of Pacific deposition in either Lower or Upper Cretaceous time. There is a distinct difference in the nature of the sediments which fill the oil-bearing basin of Comodoro Rivadavia and those found west of longitude 70.

The accompanying map indicates two separate massifs in this part of Patagonia, but it is possible that they are joined west of Comodoro Rivadavia in the vicinity of south latitude 46, west longitude 70. In any event, there is no intermingling of the late Jurassic and Cretaceous sediments of the eastern part of the massifs with those on the west.

Existing geologic maps of this part of South America indicate continental Cretaceous deposits in the basin of Comodoro Rivadavia, in the Andean area west of it, and in the Neuquen Basin to the north. It seems logical to classify them as all the same formation. This is not possible, however, since the continental deposits west of Rios Senguer and Deseado represent coal deposits formed on marginal lands and have nothing in common with the "Estratos con Dinosaurias," the "Red Beds," farther north. As to the upper Cretaceous age of the oil-bearing beds at Comodoro Rivadavia, that is a correlation based entirely on the finding of a few fragments of dinosaur bones and does not take into account many other factors which otherwise remain unexplained.

Since this is a matter which affects petroleum prospecting, it appears timely to set forth some of the pertinent data which have led the author to the conclusion ha hte oil-bearting strata in the basin of Comodoro Rivadavia are not Upper Cretaceous sediments.

Two Uplifts

There are two large anticlinal uplifts near the western limit of the basin which expose the lower part of the porphyritic tuff series; approximately the same horizon which is unconformably overlain by the Lower Cretaceous, Neocomian beds farther west, near Lago Fontana. These exposures, plus scores of wells which have been drilled in this part of the basin, indicate that the lower tuff series grade upward without any perceptible break into the oil-bearing strata. Fossils

South field, Comodoro Rivadavia

of Jurassic age are frequent in these lower tuffs.

In both of the uplifts just referred to, deep wells have been drilled and considerable shows of oil and gas encountered not only in some of the hard, sandy tuffs, but in the intercalated sands below some of the fossil horizons. These sands and tuffs are derived from the disintegrated volcanic muds which were a part of the "serie porfirica" and which were washed from the surrounding land into the intermittently deepening basin of Comodoro Rivadavia. In the middle of the basin the various oil-bearing sands are fairly uniform, but at several thousand feet are underlain by the harder and less sandy tuffs which carry the Jurassic fossils. The south side of the basin has scarcely been prospected, but scores of exploration and producing wells along the north border of the oil-producing area prove the lenticular nature of the upper sands and shales. This condition may also be seen where this horizon outcrops in the western end of the basin and where lenticular, oil-saturated sands are exposed by errosion.

In all exposures, as well as the records of drilled wells, it may be seen that, starting with the lower, hard tuffs, a few soft bentonitic shale and sand beds begin to appear. Continuing upward there is an increase in the soft beds and a corresponding decrease in the percentage of the hard tuffs. Likewise, there is no definite lower limit of the oil-bearing beds, but the porosity and permeability decrease with depth until commercial productivity is thus limited.

Nature of Beds

Clearly, the whole series represents continuous deposition of weathered volcanic muds, washed off the surrounding land mass and deposited in the sea. It has not been possible to determine the time required to fill this trough, but the whole series seems to have been deposited continuously and from the same source. At the top of the series is an unconformity marked in most places by a white sand or conglomerate composed of pure quartz. This is derived from the quartz-bearing tuffs which carry the quartz as well-developed crystals. Overlying the white sand which marks a hiatus are beds of extreme Upper Cretaceous age of Atlantic origin. They overlap not only the upper oil-bearing section, but may be seen in contact with the older fossil-bearing tuffs on the uplifts north and south of the basin.

The oil exploration in Tierra del Fuego in Chile, which the writer conducted, throws additional light on the nature and age of these tuffs. It also gives some additional clues to the possible size of these old massifs.

The massif on the south side of the Comodoro Rivadavia basin does not embrace even all of the territory of Santa Cruz, and it does not outcrop over all of the area indicated on the map. The southern limit is indicated where it is known to lie at shallow depth. Along the west side of this massif there are several hundred meters of shales and sandstones of Upper and Lower Cretaceous age. There is a coal-bearing horizon near the base of the Upper Cretaceous which has been correlated with the "Estratos con Dinosaurias" and the oil-bearing section at

Comodoro Rivadavia, but it has nothing in common, lithologically, with either of them. Clearly, it represents Pacific sedimentation.

It is the writer's opinion that the massif of Santa Cruz extends southeastward and probably includes the Malvinas or Falkland Islands. This assumption is based on the fact that these islands are composed principally of Jurassic sediments, and that the present configuration of the ocean floor indicates such connection with the mainland. Such a disposition of the land would also provide a barrier to shelter the basin of Comodoro Rivadavia from the Pacific type sedimentation which is now found on the Atlantic coast on both the north and south sides of the east entrance to the Straits of Magellan.

Origin of Sediments

All of the Marine Cretaceous sediments included in Andean folding (and this includes the district of Tierra del Fuego) had their origin in a land mass situated to the west and southwest of the present land. The principal part of the basin was a considerable distance off the present shore, since the geologic section now composing the land is principally clay shale, with only a small percentage of sandstones. This also applies to the Eocene section.

On the Patagonian side of the ancient basin was only very low land since erosion apparently contributed no sedimentation from the land on that side. The massif of Santa Cruz appears to have been quite flat and to have suffered a gentle, south-southwestward tipping, since the contact between the porphyritic tuffs and the overlying Cretaceous shales, as found in well logs in the Province of Santa Cruz, shows a very uniform slope. However, the porphyritic series dips more steeply than the contact, since the lower dense tuffs are at the surface, along Rio Deseado, while the softer series was found at Rio Gallegos and in another well 50 miles north of it. At Springhill, about 3000 feet of soft tuffs were found below the Cretaceous contact.

The entire Upper Cretaceous section, according to microfossil evidence, is represented at Spring Hill. There is no evidence of Lower Cretaceous beds, as reported in the Rio Gallegos well by Argentine geologists. That report, however, was based on a fragmentary collection of macro-fossils. The lithological characteristics of the Cretaceous section in both wells are identical, there being a complete absence of coarse grained material in the entire body of dark lead-colored shales.

Seismograph work in the vicinity of the Rio Gallegos well indicates no appreciable folding and only a slight regional south-southwest dip of the beds.

Jurassic Prospect

When petroleum exploration was initiated by the writer in southern Chile, it was with the conviction that the Jurassic beds offered more prospect for commercial oil fields than the sandstones of the Cretaceous. The latter are very seldom clean sands and have very irregular porosity, due largely to their derivation, which seems to be from basic rocks of complex composition. The result is a great variety of grain sizes with resultant poor porosity. On the other hand, the quartz in the porphyritic tuff series has given rise to clean, uniform sands, especially the sand which at many places marks the hiatus between Upper Jurassic and Cretaceous.

The drilling of the Spring Hill well indicated that the Upper Cretaceous shales are, indeed, source beds, since they showed definite signs of oil. They only lack reservoir beds. They are, no doubt, the source of the oil which was found in the 100-foot thick sand which underlies them and which is composed of quartz derived from the Jurassic tuffs.

One of the wells at Spring Hill drilled about 3000 feet of tuffaceous material below this sand, all the material being obviously derived from the older tuff series. Some thin beds of coal were found, and some sands, but no signs of oil. Unfortunately, the well selected for a deep test was one which was also outside the oil limits in the upper sand, and for that reason it cannot be definitely said that the upper tuff series has no oil possibilities.

Zone Opened

This discovery opens for prospecting a large zone in southern Santa Cruz and along the Straits of Magellan. Just how far south it extends is not known, since the strata do not dip uniformly to the south. The deepest part of the trough is about south latitude 54, and in the vicinity of San Sebastian there appears to be another large anticline. The surface dips do not give a true picture of the depth to the Jurassic beds in this basin. Along the foothills, southward from Punta Arenas, can be measured nearly 10,000 meters of Upper Cretaceous and Eocene sediments. This same section, as shown by the log of the Rio Gallegos well, has thinned to about 1000 meters.

In the mountains which make up the southern part of Tierra del Fuego may be some remnants of the old continent from which were derived the Upper Cretaceous sediments. However, they are so altered by folding and the intense heat of Upper Cretaceous intrusions of grano-dionite that it is impossible to tell much about their previous composition.

Only a thin band of the Jurassic tuffs, always highly metamorphosed, could be found by the writer. It has a west-northwest trend and follows, roughly, paralled to the southern coast. It overlies older rocks, intensely cut by quartz-filled fissures and which no doubt had a sedimentary origin, but were altered to schists even before the grano-dioritic intrusions.

Needless to say, this area offers no prospects for oil. Just north of it, however, in the foothills of the extreme southern Andes, are two thick sand series in the Upper Cretaceous which do offer some possibilities. Several structures were mapped where it is believed the sands may be sufficiently well-sorted to provide an adequate reservoir. These are typical "Rocky Mountain" structures, and like many of those in Colorado and Wyoming, may have been formed too late to trap any oil.

Conclusion

In conclusion, the writer wishes to thank the many geologists who worked under his direction, in both Argentina and Chile, for the valuable assistance which makes possible this contribution to that system of guessing, which we call the science of geology. Among those assistants, whether Argentines, Americans or Chileans, there was never complete accord, but always that healthy atmosphere of skeptical disagreement which helps to keep thinking on the track. It must also be said that the writer doubts if all his former colleagues are in complete accord with all the opinions expressed here.

To those who are interested in the subject, it is suggested that they study a recent paper by L. G. Weeks, chief research geologist of the Standard Oil Company of New Jersey. This is entitled "Paleogeography of South America," and was published in the Bulletin of the American Association of Petroleum Geologists, July, 1947.

It is fitting to quote Weeks' opening paragraph:

"Our understanding of the geology of the earth or any part of it is constantly undergoing change. The condition of change and growth as new facts come to light is one that is common to all sciences. Every geologic map is, in effect, a progress map, imperfect and vulnerable."

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TULSA, OKLAHOMA, U. S. A.

New Shell Refinery in Venezuela

SHELL Compnay of Venezuela has a modern refinery under construction at Cardon on the peninsula of Paraguana on the eastern shore of the Gulf of Venezuela. Though there is an entire lack of water on this barren desert, the site is on deep water, affording safe berths for deep draft ocean tankers and a clear run to U. S. and European ports.

Since 1945, when the project was started, Shell engineers have installed four modern units for distilling sea water for drinking purposes, and additional water for industrial and sanitary purposes is brough in by tanker and pumped from tanks to refinery and living quarters. Now, under joint consideration by Shell and Creole Petroleum Corporation, which is also constructing a refinery nearby, is the construction of a water pipe line from the town of Coro on the Venezuelan mainland, 69 miles away.

Current reports from the Shell staff at Cardon indicate that rapid progress has been made in transforming the desolate desert area into the nucleus of a well-planned model community. Already completed, after 2½ years, are one of two contemplated churches; 325 buildings which already accommodate 6500 workers; temporary electric light and power plants; sanitation and water systems; a network of over 150 miles of roads; two of three projected school buildings; a barber shop, beauty parlor, a cinema and theater for 1200 persons, and a cemetery and its chapel.

Many Conveniences

In process of construction are a large modern hospital, commissaries and mess halls, clubs, laundry, a restaurant, a commissary, a number of retail stores, a bank, a post office and many recreational facilities, such as a tennis court, baseball park, cricket pitch, a nine-hole golf course, and the improvement of several natural bathing beaches. Plans have been made for the creation of a model community to house 10-12,000 inhabitants.

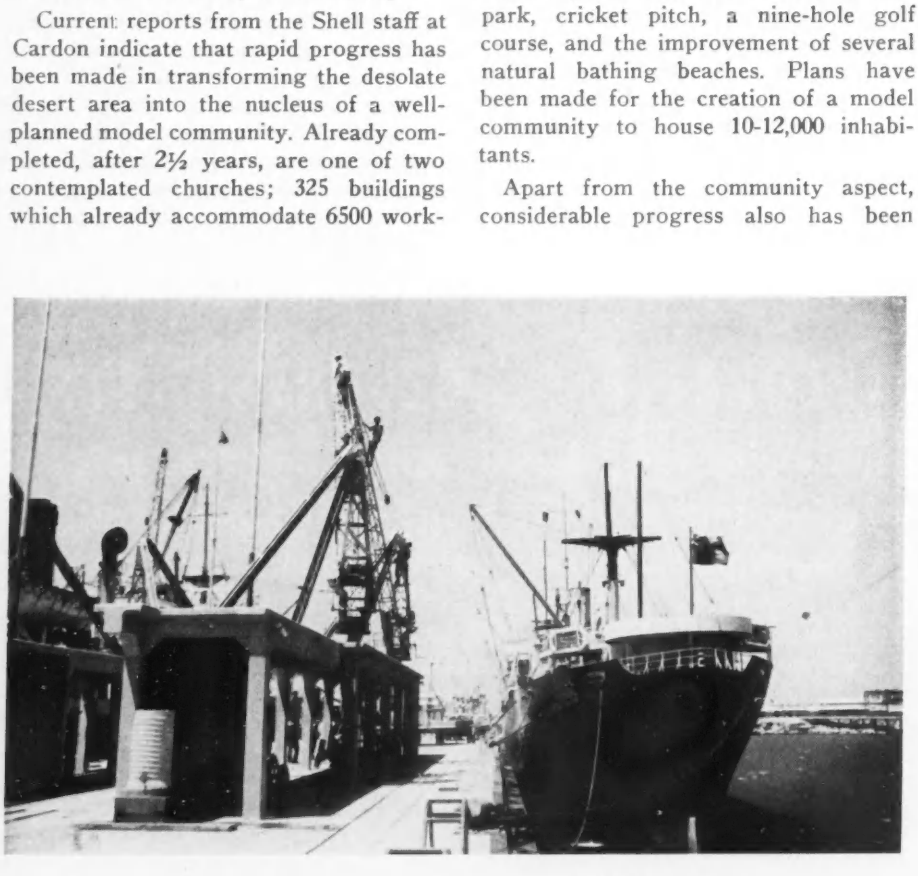
Apart from the community aspect, considerable progress also has been made in the construction of the refinery and its many adjunct facilities, in spite of the difficulty of obtaining essential materials and equipment. Already completed are 12 large storage and 15 smaller tanks, several store material buildings, extensive yard facilities, machine, electric, instrument, welding, carpenter and repair shops, a central garage building; also automotive equipment maintenance shops, a rock quarry with rock-crushing plant, a concrete block-making plant, a pipe shop, a welding school, and two barge slipways on which fourteen 200-ton barges have been built.

Under construction are many additional tanks, a crude distilling plant, a vacuum distillation plant, a redistilling unit, a cracked products separation plant, two thermal cracking plants, and a thermal reforming plant.

The first of two contemplated reinforced concrete jetties is already completed, and is now being used chiefly for the unloading of supplies from abroad. These jetties are each capable of handling simultaneously two shallow-draft tankers and two ocean-going tankers of the largest capacity. The second jetty was due for completion early in 1948.

In the area between the two jetties, several plants and installations are being erected along the ocean front: a large electric power plant, which will supply power and light for the refinery proper and for the extensive living area; a salt water pumphouse which will provide cooling water for the refinery plant; a boiler plant containing both high pressure and low pressure boilers; a fifth, large salt water distilling plant, and a boiler-feed water treating plant.

No completion date has been set for the Cardon refinery, which will have a daily production capacity in excess of 40,000 barrels of all types of refined products.



Jetty No. 1, now completed, is approximately 1440 feet long.

Celebrates First Birthday

By C. O. NICKLE
Staff Writer

CANADA'S first major Plains oil field—Leduc-Woodbend—celebrated its first birthday in February after yielding two new producers and concurrently with the announcement that Imperial Oil, Ltd., plans a $20 million exploratory and development program in the area during 1948.

H. H. Hewetson, president of Imperial Oil, also announced plans for a gas-gathering system and a $1½ million gas-absorption plant for the field. Imperial will drill 100 development wells this year, he said.

Leduc 30, completed in the Devonian lime at 5324 feet for 1560 barrels daily, and Leduc 31, completed at 5327 in the same pay for 1052 barrels daily, are the fourth and fifth wells completed on the block of 480 acres.

In the one year that has elapsed since Imperial Oil placed Leduc 1 on production with a flush flow of 1000 barrels daily, the pool has piled up an impressive record.

Between February 13, 1947, and the same day this year, 47 wells were completed within a five-mile radius of the discovery. Of these, 42 were successful, with open flow potentials ranging from 300 to nearly 3000 barrels daily. Five were failures, to delimit the field along the east side.

On the field's first birthday, 24 drilling rigs were in operation, 14 working for Imperial and ten for half a dozen independent groups. Drilling time ranges from 28 to 45 days.

Imperial has established an enviable record, with 29 completions to date, all of them successful. The company followed up its discovery with three extension efforts from 1¼ to two miles south, east and northeast. All three found the discovery zone tight, but went on to tap a deeper horizon which now rates as the field's major productive section.

Both oil zones, yielding 39 to 41 gravity crude, are in the Devonian. The upper section, now called D2, is a limestone bed found at an averaged depth of 5000 feet. It is delimited to the east and northeast by a porosity pinchout. The lower zone, called D3, is apparently a coral reef condition, found at 5150-400 feet.

After successful completion of its first three follow up extensions, Imperial embarked on a program of offsets. Meanwhile, independents went to work at stepout locations. The Cross-Dillon group pushed the proven area 1½ miles northwest with Globe-Leduc West 2; 2½ miles west with Globe-Leduc West 1; and a mile farther south with East Leduc-South Brazeau 1. Five independent failures established the eastern production limits, while other independent successes extended the producing limits with quarter-mile stepouts north, east, south and west.

By the end of 1947, the proven area covered about 8400 acres, with reserves variously estimated at 80 to 120 million barrels.

In January, Imperial-Woodbend 1 went on production from D3 with a flush flow rate of 2200 barrels daily. This well is just over three miles northwest of Leduc's producing boundaries. Drilling this year will likely establish whether Woodbend marked a doubling of the Leduc proven area, or the beginning of a second Leduc-type field.

In either case, Canada's oil men felt confident on Leduc's first birthday that the Leduc-Woodbend Area has a proven oil reserve well in excess of 100 million barrels and that in sight, was a prospective reserve that might top 200 million barrels.

By Leduc's first birthday the pool was delivering about 5000 barrels per day, with wells operating under Alberta P. & N. G. Conservation Board maximum allotments of 150 barrels daily for D3 zone wells and 100 barrels daily for D2 producers. Estimated production of the area by February 13 was slightly over 550,000 barrels.

Actual production of the area to January 31, 1848, was 490,029 barrels, of which D3 zone wells contributed 338,392 barrels and D2 zone wells 151,637 barrels. January production was 117,579 barrels, 3793 barrels daily. In January, 38 wells produced, with ten of these showing initial yield in that month. Four more completed in the first two weeks of February, with eight or nine more expected to complete later in the month.

Leduc's oil is drawing a wellhead price of $3.45 a barrel. Bulk of production is going to Imperial's refinery at Calgary, 180 miles south of the field. The balance (from most of the Independent wells) is going to the British-American refinery at Calgary. Imperial is now erecting, and will place in operation later this year, an 8500 barrel refinery at Edmonton, 15 miles north of the field. The field will be connected by pipe line with this refinery.

Deep Discovery

Canadian Gulf Oil Company, unit of Gulf Oil Corporation, was expected to place its Pincher Creek 1 discovery on production late in February. The deep (11,927 feet) Madison limestone test indicated a very heavy gas flow and considerable light oil on drill-stem test at 11,800 feet on December 28, after setting 7 inch casing to 11,755 feet. More porosity showed in deepening to 11,927 feet but, because of the very high pressures evident, no drill-stem test was attempted.

Careful and lengthy preparations have been made for production. More than 6000 sacks of cement have been loaded through perforations behind the casing, from grass roots to bottom, and high-pressure control equipment has been installed.

A brief drill-stem test at 11,800 feet gave a gas flow of 10 million cubic feet daily rate against a flowing pressure up to 3250 pounds per square inch. When

pipe was pulled, 155 feet of 47 to 50 gravity oil was recovered. Five minutes after closing of tester, a pressure of 5775 psi was recorded.

Big question to Canada's oil industry is whether Pincher Creek will be another Turner Valley (with its 100 million barrel oil reserves down flank from a gas-cap), or another Jumping Pound (which proved to be a 'wet gas' field with natural gas reserves estimated at up to 700 billion cubic feet, but with no flank oil column). Pincher Creek is south of Turner Valley and Jumping Pound in the Alberta Foothills, and is only 16 miles north of the Montana border.

Bantry Well on Production

The Standard Oil Company of California and Imperial Oil discovery at Bantry is now on production, and drilling has started at an initial followup test a mile north. The discovery is the best completed on the Canadian Plains outside of Leduc. On a drill-stem test late in 1947, the well indicated a flow rate exceeding 1000 barrels daily from a Basal Cretaceous Sand around 3250 feet. It was then deepened for test of the Madison and Devonian (where water was encountered), was plugged back, cased and gun-perforated 3253-59 feet.

Production is clean 24.7 gravity oil. It is being hauled to the Tillet railway point, three miles southeast, for shipment by rail to the British-American refinery at Calgary, 100 miles west and north.

The discovery is Cal-Imperial-Bantry 11-2-18-13, in lsd 12-18-13w4th. First followup, 11-11-18-13, is a mile north. If this well is successful, a considerably expanded drilling program for Bantry is anticipated.

Stanolind Opens Offices

Stanolind Oil & Gas Company opened its new Canadian division offices at Calgary, Alberta, on February 9. A division of the new Foreign Exploration department set up at Tulsa by Stanolind, the Calgary office is headed by Division Landman Charles Schock. Division Geologist is Al Winzeler. Seven Americans comprise the staff of the Canadian Division.

Stanolind has decided to embark on a long-term Western Canadian exploration program following up on-the-spot surveys of the Alberta situation during 1947. In the coming months, the company will carry out a general reconnaissance of the geological and land picture in Alberta, will probably also initiate a geophysical program. As yet, Stanolind has no land under reservation or lease, but that is a condition that should not be long-lasting.

Three Major Pipe Lines Planned in Canada

A New York group is planning a pipe line system to link Alberta gas fields with West Coast U. S. and Canadian cities; a Winnipeg group is making plans for a gas pipe line system to serve the Saskatchewan-Manitoba area; and Imperial Oil, Ltd., has announced plans for a 500-mile crude line from Edmonton to prairie refining centers at Regina and Moose Jaw.

Both gas lines hinge on a major change of policy on the part of the Alberta government. Alberta now prohibits export of natural gas from the province. The government takes the attitude that all gas reserves established in the province should be held for the long-term needs of the province. Government spokesmen point out, however, that if reserves should be found to be more than adequate, the export ban may be relaxed.

A commission headed by Dr. George S. Hume, chief of the Dominion Geological Survey, and including two representatives each of the Dominion and Alberta governments, is making a study of Alberta gas reserves, and was to submit its findings to the governments in late February.

The West Coast pipe line project is sponsored by the Northwest Natural Gas Company of New York. During the summer of 1947, Northwest had a survey of Alberta gas reserves made by A. D. Brokaw, head of the New York engineering firm of Brokaw, Dickson & McKee. His report was apparently favorable, for the company has been quietly proceeding with tentative plans for a pipe line.

Northwest is considering a line from southwest Alberta, across the Rockies, following an American route down the Columbia River, to serve such U. S. cities as Portland and Seattle, and swinging north into Canada to serve Vancouver, B. C. Northwest has been negotiating with several owners of large gas reserves in Alberta, but no arrangements have been or can be finalized until the Alberta export ban is eased.

A strong Winnipeg, Manitoba, financial group—Osler, Hammond & Nanton, Ltd.—has made application to the Dominion Parliament to incorporate "Western Prairie Pipe Line Company," whose objects would be to build a pipe line system from the Calgary area in Alberta eastward to serve South Saskatchewan and Manitoba communities as far as Winnipeg.

Estimated cost of the West Coast project would be $80 million. Estimated cost of the Winnipeg project would be $45 million.

Among the large Alberta gas reserves not now being used to meet that province's needs are Imperial Oil's Viking-Kinsella Reserve; McColl Frontenac and Union Oil Company of California's Pakowki Lake region reserves; Standard Oil Company of California and Independents' Princess area reserves; and Shell Oil of Canada's Jumping Pound Reserve.

Imperial's projected line to Regina would cost $20-$25 million and if extended 350 miles to Winnipeg, as is possible, would cost an additional $5-$10 million.

Stanolind is the third recent newcomer to the Alberta scene. Amerada Petroleum Corporation and Continental Oil Company established headquarters in Calgary late in 1947, have each acquired several hundred thousand acres under Crown Reservation in a 100-mile belt of virgin territory extending north from Calgary, and are starting geophysical programs this spring. Continental already has a gravitymeter party at work and is expected to bring in two seismograph parties. Amerada was reported planning a program for three seismograph parties.

Lloydminster Output Up

Peak oil production in the Saskatchewan sector of the Lloydminster field has not yet been reached, preliminary figures for January indicate, Natural Resources Minister J. L. Phelps said. Production the last month was a record high of 73,533 barrels, 2326 barrels over the previous high established in December, 1947.

"Severe weather conditions have hampered drilling," said Phelps, "and at the present time there is little activity in the field. The latest well, drilled by Imperial Oil on the northeastern edge of the Lone Rock field, was abandoned at 2136 feet without encountering commercial oil."

African Plant Planned

Anglo-Transvaal Consolidated Investment Company is preparing to build a plant for production of oil from coal in South Africa. Cost of the plant will be about £12 million and it will take two to three years to erect.

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The center blades are heavily dressed with tungsten carbide inserts to insure maximum digging efficiency, while the roller and ball bearing side cutters have large, husky, specially hard-faced teeth to offset gauge wear and maintain round full-gauge hole.

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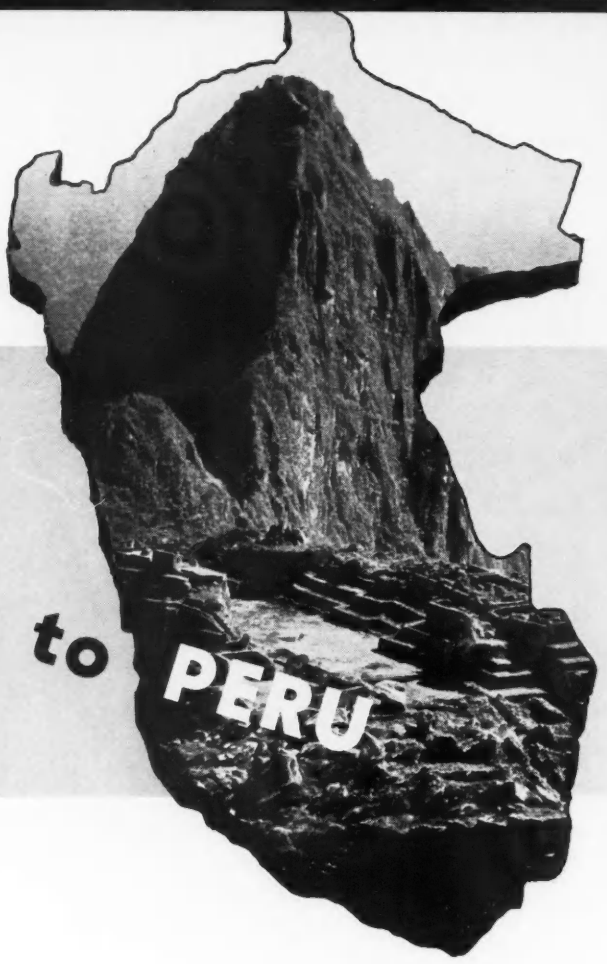
So You're Going to PERU



By GEORGE O. IVES
International Editor

SO YOU'RE going to visit Peru? We think you'll enjoy your trip whatever the nature of your business. Should your stay be short and your business pressing, you will perhaps have an opportunity for no more than a look around the city of Lima itself. This will be well rewarded, for Lima has a history dating back more than 400 years and many original landmarks are still there. You will find the people friendly and courteous, and need not be too concerned over any deficiency you may have in your command of the Spanish language.

Proposed legislation now before the Peruvian Congress would liberalize the petroleum laws to allow more freedom in acquisition of oil exploration concessions by outside companies, and upon its passage a number of companies not now active in the country are expected to enter. For the past couple of years, in anticipation of such legislation, a number of companies have been conducting preliminary surveys and geological investigations, but failure of the Congress to act has caused most of these to withdraw temporarily.

It is therefore expected that in years to come Peru will have increasing numbers of visitors traveling in the interests of the oil industry. They will be arriving from both directions of normal air travel, with perhaps more from the north than the south. Unless an oil man is making a rather complete tour of all South American producing countries, traveling down the east coast and back up the west coast he will probably come in by way of Balboa, with a direct flight to Lima on Pan American-Grace Airways. However, there are both local and through flights from both directions on international lines.

Meanwhile, several foreign oil concerns have continued development of their producing properties, and a government-owned company is also active. They are keeping 25 rotary drilling rigs running steadily and completing about 150 wells a year. Peru has activity in all phases of the industry in addition to drilling and producing. The country has three refineries with a combined capacity of around 30,000 barrels a day, and field operations at Talara and Lobitos, on the Pacific coast near the northern border involve use of gasoline and cycling plants, pipe line transportation, packaging of refined products, and tanker loading facilities.

Musts For Travelers

An American oil man planning a trip to Peru would do well to get acquainted with the latest regulations of the departments of immigration and health, to see that he has complied with all requirements. At this writing the traveler needed the following: A U. S. passport, valid visa obtained from a Peruvian consulate, smallpox vaccination certificate preferably less than two years old, health certificate that states he is free from contagious diseases or serious disability and is not a chronic alcoholic, epileptic or drug addict, police certificate less than 30 days old, letters of recommendation in duplicate on the letterhead of the company he represents, and five frontview passport photographs. He must have the certificates, photos and passport at the time of application to the consulate for a visa. All papers required by the country should be kept handy for presentation to the officials at the port of entry. The writer was not told in advance of this at the time of his first trip and had to cool his heels on a bench until the luggage was unloaded from the plane and sorted out for inspection. He then had to dig his papers out of the luggage where he had so carefully deposited them for safekeeping. Having a passport and visa alone are not enough.

Another requirement is a yellow fever inoculation certificate not less than six weeks old or in the case of Peru more than four years old. This is not required for travel into South American countries, but is required by U. S. health authorities for re-entry after travel to certain latitudes.

Although the oil traveler will doubtless want to visit the oil fields at Talara, Lobitos, and Zorritos, his first stop should be in Lima, headquarters of the operating companies. International Pe-

In Lima may be seen modern boulevards lined with new buildings.

Chorillos, on the coast near Lima, is the site of the Prado Museum, a private establishment containing many fine objects of colonial and pre-Colombian art.

troleum Company maintains extensive offices at Lima, and the general administrative offices of Lobitos Oilfields, Limited, directed by Milne & Company, are there, in addition to the headquarters of the Compania de Petroles Ganso Azul. The government-owned Establicimientos Petroliferos Fiscales is also quartered in the capital city. Petroleum affairs are under the general direction of the Ministry of Fomento with the "Direccion de Minas y Petroleo" the department actively in charge. All arrangements for visits to the fields should be completed with the administration of the various companies. The coastal fields may be reached by highway from the capital city, or by air on international or local lines.

In most of South America the safest plan for the traveler unfamiliar with the cities is to get in a taxicab, give directions, and wait for the driver to deposit you in front of the proper building. But in Lima I followed this same procedure only once. Thereafter I started asking questions beforehand. I came out of the Gran Hotel Bolivar and caught a cab on the northwest side of Plaza San Martin, gave directions, and with a pleasant "Si, Senor" the driver proceeded about three blocks up a narrow, busy street, turned right at the first cross street on which traffic was moving our direction, turned right again at the next intersection, and finally after about 15 minutes, drew up with a flourish at a building directly across Plaza San Martin from where he had picked me up. This building houses the extensive offices of the International Petroleum Company, and fronting on this plaza will be found the U. S. Embassy and the offices of the Compania de Petroleo Ganso Azul.

The Gran Hotel Bolivar, the largest and most popular hotel in Lima, is in the center of town on the plaza. Only slightly less popular is the Hotel Maury which is said to be second to none in South America in the excellence of its cuisine. In the beautiful outlying section of San Isidro is located the Country Club where hotel facilities are available.

Lima has more than half a million people and is the site of the first Spanish capital of South America. When founded by Francisco Pizarro in 1535 it was called the Very Noble, Notable and Loyal City of the Kings of Peru, but the high-sounding Castillian name was soon discarded in favor of the name it now holds, a corruption of the name of the Rimac River on which the city is situated. For more than 200 years it remained the only capital of South America for Spanish rule, the city from which the Viceroys directed the exploitation of the mineral and other riches of the continent after the overthrow of the ancient Incas. During this time it was the main port and distribution city, and was a center of development of architecture and fine arts. The San Marcos university, established in 1551, is the oldest seat of higher learning in the Western Hemisphere, and is still in existence. It abounds in historic churches, palaces, and other buildings which have stood for 300 to 400 years, and in which much of the ancient magnificence has been preserved.

In contrast, the newer residential districts are modern and completely charming, and new apartment, hotel, and office buildings stand throughout the city side by side with edifices hundreds of years old and steeped in tradition.

Good Climate

The climate of Lima is temperate, in sharp contrast to what might be expected so near the equator. Travellers should bring clothing suitable for fairly warm days and chilly nights for most of the year, and should have medium weight suits and coats if they are there during the months from June through October. The entire coastal strip of the nation is kept rather cool by the air from the Humboldt Current flowing from the near-Antarctic regions. Many of Lima's days are overcast during most of the morning and afternoon, with sunshine for a short time in the middle of the day, but it will not be necessary to bring a raincoat to Lima. It simply doesn't as rain is known elsewhere. When one speaks of rain in Lima he refers to a light mist, or drizzle, which will in time wet the streets and sidewalks, but which never calls for raincoats. Actually, most of the buildings and residences do not have roofs built

to withstand rain, because they aren't called on to withstand it. It is said that once, about 25 years ago, there was a freak temporary shifting of the Humboldt Current, and for a short time the region was subjected to terrific downpours of rain, causing much damage because the roofs were constructed to act as little more than shade from the sun. Since then rains have been unknown. In the mountains and the jungle country on the eastern side of the Andes, rainfall is normal.

One cannot but be impressed by the arid ruggedness and desolation of Peru's coastline as viewed from planes coming in from north or south. With the exception of extremely narrow strips in the valleys of occasional streams winding down from the mountains, the entire coast is a desert. The city of Lima, being in the valley of the Rimac, has water available for irrigation, and plant life is vigorous.

Americans and Britons going to Peru need not fear that they will be alone in a strange land. American commercial interests have been established in Peru by nearly 50 firms, covering all representative phases of home industry, with British and Canadian firms interested in almost as many. Organizations and institutions have been established for the foreign colony covering all phases of cultural, educational, religious, and recreational life of Anglo-Americans. These include such organizations as women's literary clubs, the Peruvian-North American Cultural Institute, Y. M. C. A., churches and bible institutes, golf clubs and other sporting and social clubs as well as elementary and higher educational institutions for English-speaking people.

Still in use in Lima are many old buildings erected during Spanish colonial days.

Recreational Facilities

Many opportunities for entertainment are offered. Lima boasts a number of first-class places for dining and dancing. Within a short ride from Lima by auto are no fewer than six excellent beach resorts which are quite popular from December through April, when the coastal strip enjoys most of its sunshine. Golf and tennis clubs are available, along with such typically Latin sports as bull-fighting and cockfights.

The Incas of old were noted for their craftsmanship, working in silver, gold, wood, leather and stone, and many examples of their handicraft are to be seen. The craftsmanship has been preserved by present-day Peruvians and many beautiful and relatively inexpensive examples may be obtained in the shops which abound in the business section of the city.

In the stores and markets of Peru, as in most larger cities in South America, it is possible to find almost any article of wearing apparel or food which is available in the U. S., with the understandable difference that the price on imported items is higher than in the country of origin. Suits, shirts, shoes, neckties, etc., of almost all familiar American brands may be had, although prices are high. Many items of American and British canned or preserved foodstuffs may be bought on the same basis, but the imported food and clothing items are apparently somewhat lower than in some of the other South American nations.

Housing was none too plentiful toward the close of last year, but construction was proceeding actively. Cost of rental of houses and apartments does not seem exorbitant in Peru. In most other capitals of the continent accommodations are considerably higher than similar facilities in the U. S.

The British-American Hospital, which recently moved into larger quarters consisting of three new buildings, offers complete facilities with American and Peruvian doctors and nurses, and is an institutional member of the American Hospital Association.

The monetary unit of Peru is the sol, which is divided into 100 centavos, and coins are issued in 5-, 10-, 20-, and 50-centavo denominations. At current official rates of exchange the U. S. dollar will buy 6½ soles. However, a certain amount of inflation has been apparent in recent months in the free market and it is possible to buy 14.4 soles for a dollar. At the same time all import and export business is controlled by the "Consejo del Comercio Exterior" and is on the basis of the official exchange rate.

Through its control of imports and exports, the Consejo issues licenses for every transaction involving shipments of any commodity into the world markets, or purchase of foreign items for import. This control exercises some degree of restraint on disbursement of foreign exchange, which during the past couple of years has been the government cause for concern. Declines in world prices of several of the nation's export commodities, plus diminished production, caused successive drops in exchange receipts during 1946 and 1947, with an expected further drop in 1948. This decline has not been halted, though the government for a time suspended granting of permits providing for payment with unofficial exchange.

Oil operators exporting shipments of crude oil and products are required to make an exact declaration to the council of just how many barrels are to be shipped to what destination within the next 30-day period, together with an estimate of the value of the cargos. After the permit is granted and shipment is effected, the shipper must pay the government the value of the cargo in foreign currency and the Council then authorizes payment to the company of the equivalent value in soles. An awkward situation for the shipper sometime arises when he finds, after making his declaration of intent to ship a certain amount, that his requirements are larger, as in the case of an emergency order. He then must wait another 30 days before going through channels and obtaining permits for the additional amount.

In purchasing souvenirs of the country it must be remembered that certain articles are not allowed to leave. Baggage is subject to examination by the customs officers on leaving as well as upon entering the country, and such things as objects of historical or archeological value may not be taken away. Also forbidden are foodstuffs, as well as skins of vicuna or chinchilla or objects manufactured from these skins. Export taxes must be paid on silver leaving the country, but amounts weighing up to 11 pounds per person may leave without an export license. Amounts over this must be covered by license obtained from the Ministerio de Hacienda. In making purchases of silver articles the dealers fill out forms designating the weights and amount of tax paid. The forms serve as a receipt when leaving the country and also serve to establish the value upon inspection of U. S. customs. Normally small quantities are considered in the classification of gifts and souvenirs and can leave tax-free.

Baash-Ross News

BAASH-ROSS TOOL COMPANY · LOS ANGELES · HOUSTON · NEW YORK

OUR 28th YEAR

NOW 2 types OF BAASH-ROSS SAFETY CLAMPS!

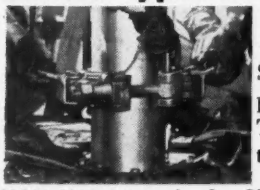
1. BAASH-ROSS TUBING SAFETY CLAMP (TYPE "T")

A new size Safety Clamp for taking a firm non-slip grip on Tubing and other small diameter pipe from 1 5/16" O. D. to 4½" O. D. inclusive.

2. BAASH-ROSS STANDARD SAFETY CLAMP (TYPE "C")

The well-known standard size Safety Clamp for taking a firm non-slip grip on pipe, drill collars, liners, etc. with O. D's from 3¾" to 13⅜" O. D. inclusive.

BOTH types have these same unique advantages...



QUICKLY APPLIED: To apply either the Tubing or Standard Safety Clamp, simply wrap the flexibly-linked unit around the pipe, insert a pin and cinch tight with the quick-acting wrench. That's all you do to safeguard against dropping flush-jointed tubing, pipe, drill collars and similar equipment down the hole.

NON-SLIP GRIP: As the Clamp is tightened individual spring-loaded slips in each link take a firm initial grip on the pipe. Should the pipe start to drop these slips wedge tighter as the load increases, firmly locking the Clamp to the pipe so that it cannot slip.

WIDE OPERATING RANGE: By simply adding or removing links—a quick, easy operation—both the Tubing and Standard Safety Clamps can be readily adapted to gripping a wide range of diameters. For each link added or removed, a Clamp's range of diameters is increased or decreased one inch, respectively. The Tubing Safety Clamp handles pipe diameters from 1 5/16" O. D. to 4½" O. D. inclusive and the Standard Safety Clamp pipe diameters from 3¾" O. D. to 13⅜" O. D. inclusive.

MANY VALUABLE APPLICATIONS:

There are so many time-saving, labor-saving and trouble-saving uses for the Tubing and Standard Safety Clamps that no rig should be without them. Besides safeguarding against dropping flush tubing, drill collars and other hard-to-handle equipment, use them (1) for providing emergency elevator shoulders when lifting "twist-offs," flush liners, gravel-packed liners, etc... (2) as a grip for pulling line pipe into position, or holding it aligned while welding joints... (3) to simplify the setting of casing and landing head equipment—and many other uses. Your nearby Baash-Ross representative will gladly give you the details... or write direct.

FRENCH MOROCCO DISCOVERY

Most Important in Africa Outside Egypt

By N. A. KENDALL
Petroleum Engineer and Geologist

Rig that drilled the discovery well.

THE most important oil discovery in Africa outside of Egypt occurred in November with the completion of a French Moroccan wildcat capable of producing 1275 barrels daily on open flow. Small production has been obtained in Morocco and neighboring Algeria for some years, but nothing approximating this producing capacity has ever before been found in northwestern Africa.

General Geology

There are three sedimentary basins in French Morocco which are of interest for oil exploration:

1. The Miocene basin of Rharb, roughly enclosed by the triangle Rabat-Meknes-Larache. This geosyncline has for approximately ten years been the scene of operations of the Société Cherifienne du Pétrole (SCP), a company wholly owned by the French government and the Moroccan Administration.

2. The Miocene basin of Guercif-Mouilouya, connecting with the Rharb Basin through a corridor and extending along the southern border of Spanish Morocco into Algeria toward Oran. Some oil is found near Tizeroutine, 35 miles northwest of Guercif. In Algeria and Tunisia the search for oil is carried on by the Société Nationale de Recherche et d'Exploitation de Pétrole d'Algerie (SNREPAL), owned entirely by the French government.

3. The Cretaceous basin of Chaouia, between Casablanca and Marrakech. This basin is mainly known for its production of phosphate, which is found on the surface.

The northeast and east boundaries of the Rharb Basin are formed by high hills, which east of Petitjean are formed by intense folding, forming anticlines with surface expression and which were the scene of the efforts of SCP for oil exploitation about ten years ago. Numerous wells were drilled there, many as deep as 6000 feet, starting in the Cretaceous, traversing many faults and penetrating into the Lias or Lower Jurassic. Some production was established at Tselfat, amounting to only 20 barrels per day for all wells, and at Bon Draa, with a similar production. Small but commercial production is being developed at Ain Hamra, north of Souk-el-Arba, in the extreme northern part of the basin. This production is from thin sandstringers in the Miocene and amounts to only about 20 barrels per day for all wells combined.

Efforts are mainly concentrated on establishing production in the basal member of the Miocene. Following is the section of the Miocene in the Rharb Basin:

1. Sahelien; sandy, regressive facies.

2. Tortonien; together with Sahelien always at least 3300 feet thick.

3. Helvetien, 650-2600 feet thick.

4. Burdigalien; sandstones, 15-100 feet thick. Productive since November, 1947, in Oued Beth 7, north of El Kansera in the extreme southern part of the basin, with a capacity of 1275 barrels of oil per day. This formation is the objective for wells drilling all over the basin.

The Miocene unconformably overlies the basement rock, mostly Paleozoic, and the Burdigalien forms the transitional facies or basal sand of the Miocene. It is often coarse to conglomeratic.

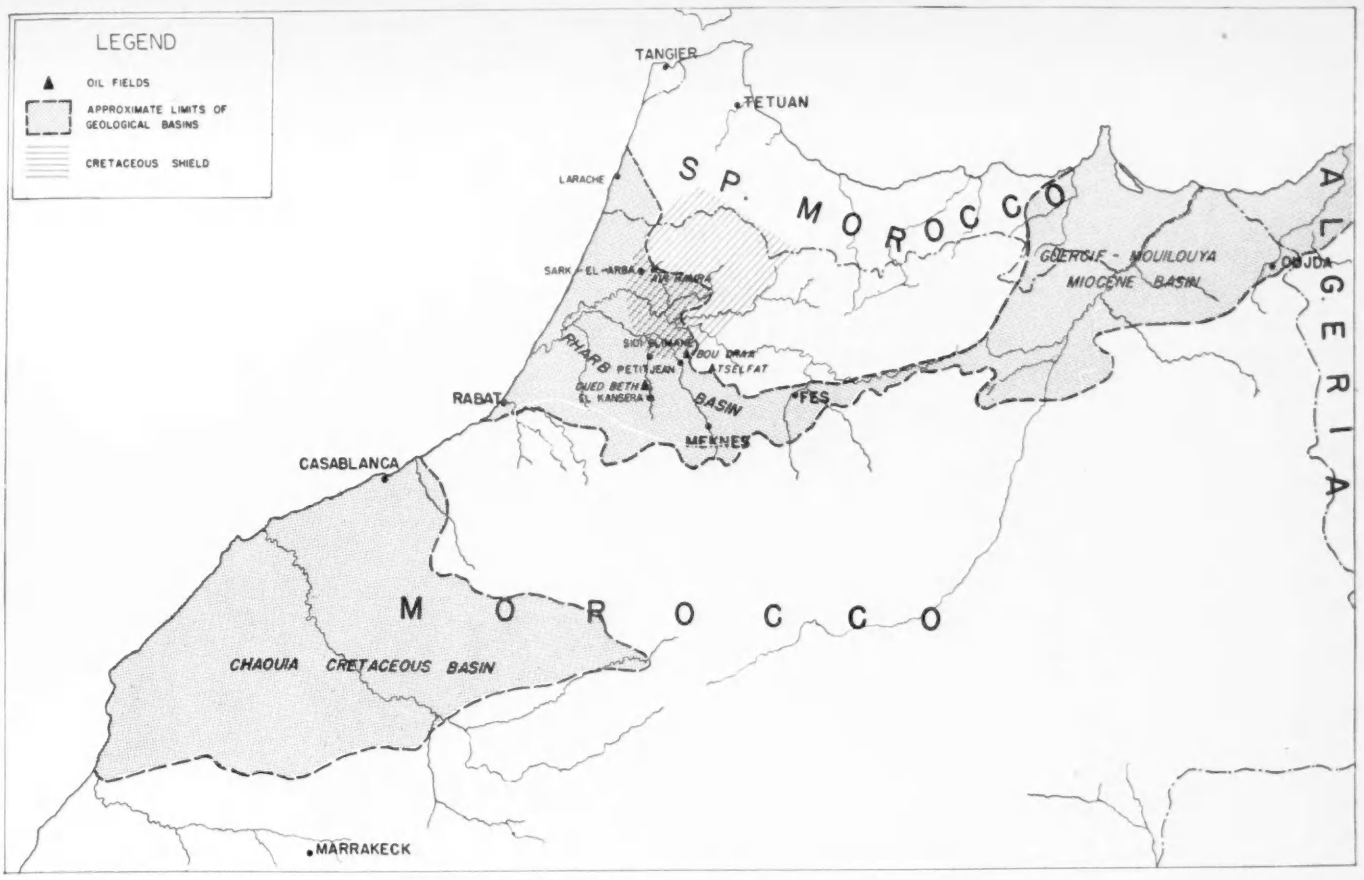
The geology is complicated by a Cretaceous shield or intrusion into the Helvetien shales. This shield is a few hundred meters thick, and consists of Cretaceous formations, which, it is visualized, were forced by the diastrophism in the hills and mountains to the east of the basin as a plastic mass into the Helvetien, dragging along fragments of the Oligocene and other formations which it passed on its way. This shield extends about halfway into the basin and is encountered northwest of Souk-el-Arba and in wells south of Sidi Slimane, but not in Oued Beth, where production is established. It might, however, also be possible to explain a shield of this size as a depositional feature of washed-in debris. An idea of its composition can be formed by studying the outcrop on the geological map in the region to the east of the basin. The drill bit therefore passes from the Helvetien into the Cretaceous and back into the Helvetien, before reaching the Burdigalien.

Excellent correlation exists in the Helvetien and Tortonien by means of micro-paleontological markers. Cristellaria, Vaginulina, Epistomina, Cibicides, Ptychomiliola, Siderolites, Ceratobulimina and Elphidium are some of the genes used as markers in the Helvetien; and Nummoloculina, Bolivina, Texuluria Carinata d' Orbigny, Planorbulina, Luterella, Pyrgoella and Cancris in the Tortonien.

The structure of which Oued Beth 7 was the discovery well is, according to data available at that time, a buried hill, with the Miocene overlying the Paleozoic. The well, drilled to 3250 feet, was producing 115 barrels of oil daily through 5/64-inch choke, with a tubing pressure of 465 pounds per square inch, and with a negligible amount of gas. It was capable of producing 1275 barrels daily, but production was cut back due to limited transportation facilities. The character of the production points to a water drive reservoir, which along with the depth and type, if not size of structure, has points of similarity with the East Texas field. The oil is being run through a topping plant at Petitjean, whence it is being taken by Shell in tank cars and transported to Oran.

Drilling Conditions

Oued Beth 7 was drilled with a portable rig to 3250 feet in ten drilling days, maximum rate of penetration having

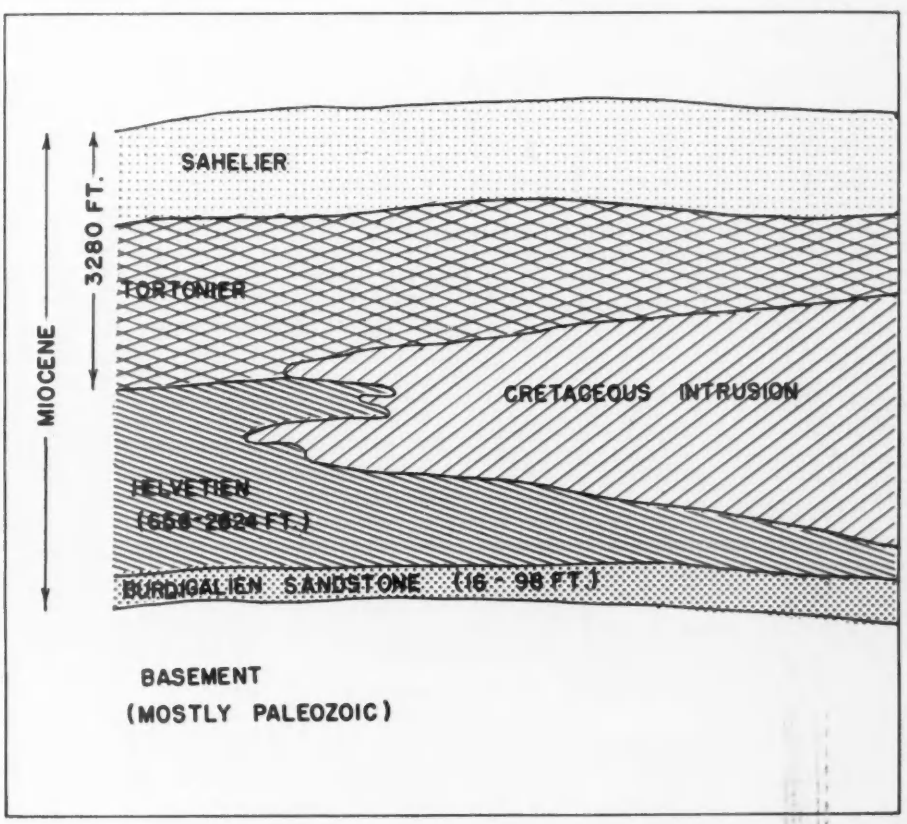


Sedimentary basins of French Morocco.

been 675 feet in one day. Oued Beth 8 was drilling in red shale and anhydrite at 3700 feet and had a drilling record similar to No. 7, with the same rig. Other parts of the basin are not as easy to drill, partly due to the presence of the Cretaceous shield. Part of the trouble was caused by gas-carrying Miocene shales, which although not bentonitic in character, were inducive to the forming of cavities with subsequent sticking of drill pipe. In addition, proper mud control was being complicated by the high salt content of most of these shales. Identification of these trouble-creating factors and their early recognition by certain symptoms while drilling had showed the way to overcome these drilling difficulties.

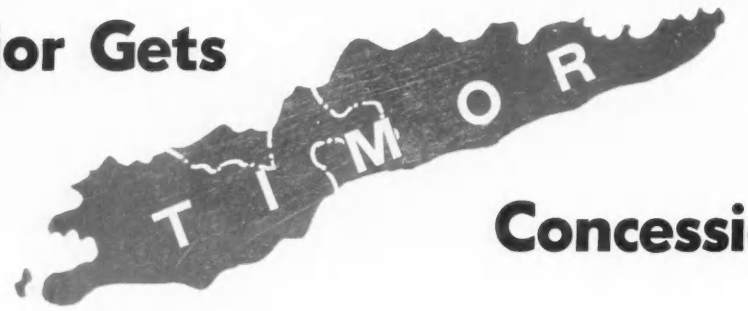
Several new rigs with jackknife derricks were in use to carry out the exploration program in these parts of the Rharb Basin. This involved drilling to projected depths of 4000 to 5000 feet.

Operation headquarters is at Petitjean, where Berquint, chief engineer of the SCP, is in charge of operations, assisted by Roger Gouteyron, superintendent of production and special services and De Reure, drilling superintendent. Chief mud engineer is Emile Dutrieux, who had just returned from an extensive visit to the U. S. F. W. Dallas, well known in the Texas and Louisiana Gulf Coast, had just arrived from Southern France to assist in setting up an educational program and driller's school at Sidi Slimane, under the sponsorship of the Institut du Petrole, Paris, as well as to advise in drilling operations.



Schematic geologic column in northeastern Rharb Basin.

Superior Gets Concession



THE Superior Oil Company has obtained an exploration and drilling concession on Timor in the East Indies. Timor is an island in the Malay Archipelago, 400 miles northwest of Australia, and is partly under Portuguese rule and partly under Dutch control. Superior's concession covers about 3000 square miles, representing nearly half of Portugal's dominion in the island.

Terms of Superior's concession which has just been negotiated with Lisbon include an initial five-year exploratory period, with another five-year renewal option. At the end of the first five-year period, the company is to select areas favorable for development, turn back the rest of the acreage, and begin small annual rental payments to Portugal. Royalty, once production begins, is fixed at 5 percent of output value up to 5000 barrels a day and graduates up to 12 percent at 50,000 barrels a day. The concession grant is the result of negotiations which Superior has carried on with Portugal since July, 1946.

Two company geologists will proceed to Timor immediately. They are Arthur Feldmeyer and Burnett Jones, who will take initial equipment consisting of jeeps, camp supplies and provisions. Local offices will be maintained at Dili, capital of Portuguese Timor.

Despite its proximity to Australia, Timor is an out-of-the-way place to reach. Shipments go by way of Batavia or Macassar and then are transshipped, requiring about three weeks for transit. A fortnightly plane service connects Dili with Australia.

Timor was occupied by the Allies in 1941, then the Japanese took over Portuguese Timor in 1942. Bomb destruction dislocated the island's communication system and food sources, and Superior's personnel will depend largely on imported supplies.

Exploration and drilling work present the typical tropical difficulties. The climate of Timor is extremely warm with long rainy periods. While no oil has as yet been discovered in Portuguese Timor, in the neighboring Dutch part of the Archipelago both tin and oil are important mineral resources. The Companhia Ultramarina de Petroleos, representing joint interests of the Royal Dutch Shell Group, Anglo-Iranian Oil Company and the Standard-Vacuum Oil Company, has had a concession covering the northeast part of the island since November, 1939, and had started exploration which was interrupted by the war. The work was resumed in 1947. Still earlier, some geological study was carried on by the Hongkong Corporation representing French and other interests.

R. M. Allan, vice president of Superior, has gone to Portugal to set up the operating company, Companhia Petroleos Superior de Timor, SARL. He estimates that the start of drilling operations are more than a year distant, depending on progress of the geological party. Seismographic work might be undertaken later, he says, and adds that whether the "Flying Magnotometer" will be used in Timor depends on check studies of its results in the Bahamas.

Pakistan Production Drop Halted

The drop in production from Pakistan's Dhulian field has been halted as a result of minor deepening and acidizing. No permanent change can be expected, however, in the slowly declining production.

The Attock Company has been conconcentrating during the year on developing the new Balkassar field. Balkassar 1 is producing steadily at a higher figure than the average of the previous year from a zone immediately above the Sakesar limestones which produce at Joya Mair. Balkassar 2 struck a large flowing volume of salt water at 4560 feet and it is being allowed to flow with a view to exhausting it. Balkassar 3 was carried successfully through this water zone, which was cemented off. It was then deepened through the producing zone of the first well in order to test the Sakesar limestone. Initial results in the Sakesar were very satisfactory and the well produced over 300 barrels per day open flow and 150 barrels per day through choke. This well, 5000 feet from No. 1, is thought to have proved a large productive area and drilling has begun on a fourth well.

It has been possible to carry out only preliminary work of the new pipe line from the Balkassar field to connect with the Dhulian-Rawalpindi pipe line because of the delay which was experienced in obtaining rail transport from the port to the site. A start is about to be made in actual construction, but due to the present communal troubles and consequent shortage of skilled labor, there is no likelihood of it being laid as soon as in normal times.

At Joya Mair 3, mechanical difficulties were encountered at 9016 feet and it was decided to stop drilling. It had been hoped that this well would allow evaluation of the productive area of Joya Mair.

At Meyal, the third test well is now below 5500 feet. A considerable amount of prospecting has been carried out in other areas.

The Burmah Oil Company's test drilled north of Joya Mair encountered difficult structural conditions which prevented a test of the limestones, and another well is about to be drilled in the area adjoining the Balkassar field.

Pakistan operators experienced great difficulties during the past year owing to the communal troubles following the partition of the Punjab, which resulted in the departure of much of the staff.

Wherever there's oil—

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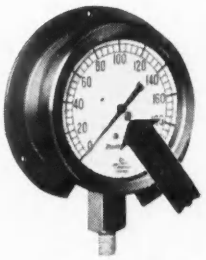

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Two Wildcats Started by Chilean Government

TWO new wildcats are being started by the Chilean government on Tierra del Fuego Island, one of which is to test the possible extension of the Spring Hill field. This well is being drilled at Espora, about ten miles due north of Spring Hill following selection of the location on the basis of further and recent geological surveys of the Spring Hill structure. Until the beginning of this year the Spring Hill structure was mapped as a closed anticline about two miles long. Recent exploration has led Chilean geologists to the belief that the structure may continue virtually to the northern tip of the peninsula of Tierra del Fuego.

On the basis of current tests and the projected extension of the structure, reserves of the Spring Hill field lately have been estimated by Chile at around 20 million barrels.

The Espora test was to get under way about February 1 and a second wildcat test will be spudded in at San Sebastian, 40 miles southeast of Spring Hill, late in March.

Wells 11 and 12 are just being completed at Spring Hill and the new wildcats are awaiting removal of the rigs to the new locations. Six wells were completed during 1947 by Chile's oil agency, the Corporacio de Fomento de la Produccion. All of these were development wells at the Spring Hill field. Two of the six completed were gas producers, the other four oil producers. Producing horizons depths in the field are about 7500 feet.

Spring Hill's discovery well came in on December 28, 1945, and tested about 1000 barrels a day through a quarter-inch choke. No. 2, the deepest yet drilled at Spring Hill, went to 10,800 feet and was a dry hole. No. 3 was a gas producer which has not yet been measured. No. 4 is still inconclusive because of drilling trouble encountered last December. It is probably a dry hole. No. 5 is a gas producer, and No. 6 both a gas and oil producer, but mainly the former. No. 7 tested 629 barrels a day through a quarter-inch choke, as did No. 8. No. 9 tested 400 barrels a day through a three-sixteenths inch choke and about 1000 barrels a day through a five-sixteenths inch choke. No. 10, completed November 30, tested about 500 barrels daily. All the wells are now shut in pending construction of a pipe line and storage tanks.

During 1947 considerable exploratory work was carried out by Chile around the producing area, the world's most southern oil field. The Corporacion de Fomento reports seven geological party-months of work for 1947, eight seismographic crew-months during the year and four gravitymeter crew-months.

Drilling has been slowed recently because of lack of equipment but adequate supplies are now on hand for continuous work on the two new wildcat tests. Three rigs are in the field, two in operation. One is working with 3½-inch drill pipe, the other uses 4½-inch pipe.

Chile is planning a 10,000-barrel refinery at Punta Arenas and has already completed harbor dredging at Caleta Percy Bay on Tierra del Fuego, across from the site on the mainland where the proposed refinery will be located. Material for the refinery will be purchased in the U. S. and England. The pipe line probably will be a 12-inch line, about 50 miles in length, running between Spring Hill and Caleta Percy Bay. The line is scheduled to be opened by the end of 1949 with two stations in operation, one pumping and one heating. Temperatures at the field are around the freezing point for six months out of every year, and it has not yet been determined to what degree the Spring Hill crude must be heated for efficient pipe line transport, although one analysis establishes a 62 pour point.

The refinery when in operation will supply most of the product to meet South Chile's petroleum demand. Total product demand for the entire country is now 18,000 barrels a day, of which a 12,000-barrel demand centers in North Chile. This requirement is all fuel and diesel oil. Of the remaining 6000 barrels current demand, however, for South Chile, about 4000 barrels a day constitute gasoline requirements.

Colombia's 1947 Production Tops All Years Since 1940

Data released by Colombia's Ministry of Petroleum summarizing 1947 activity showed oil production exceeded 1946 and all previous years since 1940.

Twenty-two wildcats were completed, five being productive. The producers were Dificil, 2; Las Monas, 1; Tablon, 1 gas well; Velasquez, 1 (discovery well). The Velasquez discovery and the Tablon gasser were the only significant discoveries.

In the four commercial concessions, De Mares, Barco, Yondo, and Cantagallo, 138 wells were completed, 131 of which were productive. The producers were De Mares, 93; Barco, 20; Yondo, 18. The one well drilled at Cantagallo was dry.

Commercial concessions reported the following production for 1947: De Mares, 12,447,925 barrels; Barco, 7,737,446 barrels; Yondo, 4,779,562 barrels; Cantagallo, 24,689 barrels. The total was 24,989,622 barrels.

Non-commercial concessions yielded the following production: Dificil, 118,566 barrels; Las Monas, 9,109 barrels; Floresanto, 197 barrels; Teran-Guaguaqui (Velasquez) 30,434 barrels. The total was 158,306 barrels.

Barinas Well Evaluated

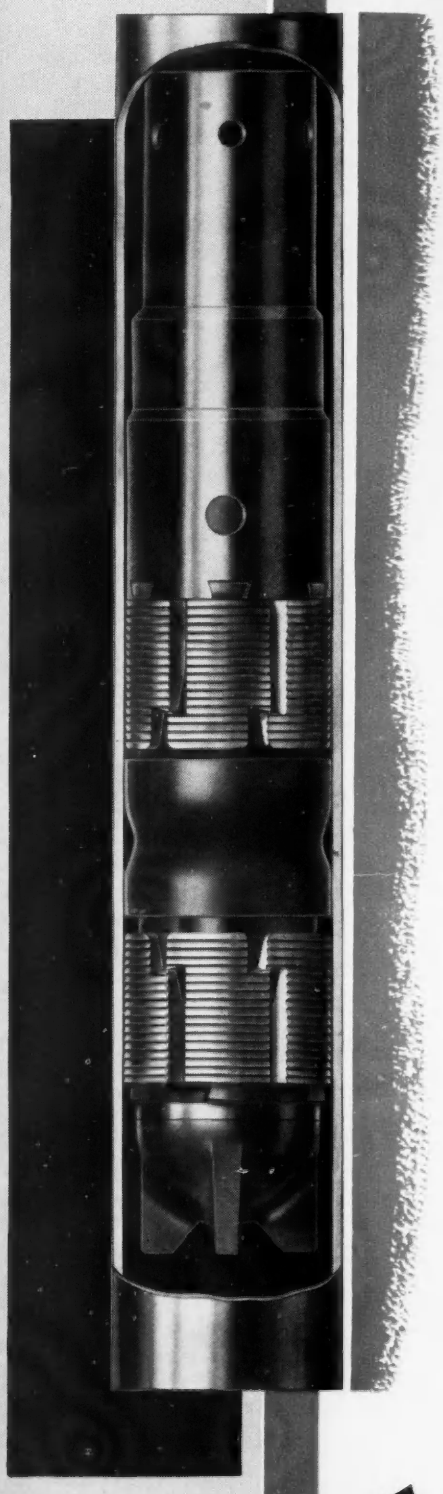
One rig is being used for continued operations in the new oil field discovered by Socony-Vacuum Oil Company in the state of Barinas, Venezuela, and it is not likely that more equipment will be placed in service before further evaluation of the find has been completed. The discovery, Silvestre 2, produced about 700 barrels daily on preliminary tests through ¼-inch choke, and had a satisfactory pay section in the Eocene formation, but is an isolated location for establishing outlets for the oil. Sands were found from around 8600 feet, down to below 9300 feet.

Threatened Oil Price Hike In Austria Is Canceled

The Russian Oil Marketing Corporation in Austria announced that the threatened 100 percent price increase on petroleum products from the Russian-controlled Austrian fields will not be put into effect. This follows an appeal by the Austrian government to the Allied Control Council.

Reason given by the Soviet authorities for the proposed drastic rise in prices was the need for making capital investment in the Zistersdorf fields. This is a significant departure, since the Russians have hitherto made no investment in these fields which they took over as German assets. Another Russian explanation was that prices of Soviet-controlled products had to be raised because the Austrian government was discriminating against Russian concerns in allocating materials.

SET



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33 Mexican Rigs Running As New Year Began

AT THE end of 1947 there were 33 rigs operating in Mexico, of which 13 were active locations, 14 were drilling, and 6 were shutdown or suspended. All rigs were operating for Pemex.

The Poza Rica area was the most active with 14 rigs, 6 of which were active locations, 3 were drilling, and 5 were suspended. These 5 suspended operations had drilled into the producing zone and undoubtedly are all producers. Work was probably suspended for lack of tubing to complete.

The Northern district had but one drilling operation. There were five rigs running in the Northeast district and the same number in the Southern district. The remaining eight operations were in the Isthmus area.

There were 50 wells completed in the country during 1947, of which 20 were in the Isthmus of Tehuantepec and ten in the Poza Rica area. Twenty-three of the completions were oil producers, 2 were completed as gas wells, and the remaining 25 were dry holes. Eighteen of the completions were wildcats and these resulted in three oil wells and one gas well. The 50 wells completed during 1947 were one more than the 47 completed during the preceding year. This was the second largest number of wells completed in any year since expropriation in the spring of 1938, comparing with 58 completions in 1945. An accompanying table lists all the wells completed in Mexico during 1947.

Since expropriation, Pemex has drilled 292 wells, of which 158 have been oil or gas producers and 134 have been dry.

Wells Completed in Mexico During 1947

(All by Pemex with the exception of No. 9 Rancherias in the Northeastern District which was drilled by Ohio Mex)

WELL	Field, Hacienda and State	Date Completed	Depth (Feet)	RESULT
Northeastern District:				
Mision 9	Mision, Reynosa, Tamaulipas	1-27	6178	Junked hole.
Trevino 1	Wildcat, Reynosa y Matam., Tamaulipas	4-23	8894	Dry hole.
Rancherias 9	Camargo, Tamaulipas	5-15	1215	Abd. No funds.
Mision 8	Mision, Reynosa, Tamaulipas	5-30	5577	Junked hole.
Camargo 4	Wildcat, Parc. B., Camargo, Tamaulipas	7-1	3596	Gas (MCF pending)
Cuchillo Parado 1	Wildcat, Ojinaga, Chihuahua	7-23	8480	Dry hole
Camargo 5	Parc. B., Camargo, Tamaulipas	9-27	2401	Gas (MCF pending)
Mision 10	Mision, Reynosa, Tamaulipas	10-31	9170	Dry hole.
China 2	Wildcat, Carlos Cantu, Nuevo Leon	12-18	5817	Dry hole
Northern District:				
Dicha 168	Chapacao, Veracruz	1-30	2108	Salt water.
Limon 118	Wildcat, Hda. Limon, Veracruz	2-17	2142	200 b/d oil.
Dicha 166	Chapacao, Veracruz	6-4	2244	200 b/d oil.
Limon 119	Wildcat, Hda. Limon, Veracruz	6-9	3185	Dry hole.
Limon 113	Hda. Limon, Veracruz	10-20	2713	125 b/d oil.
Limon 120	Wildcat, Hda. Limon, Veracruz	12-27	3131	Dry hole.
Southern District:				
Soledad 4a	Wildcat, Frac. A, La Noria, Veracruz	3-25	8375	Dry hole.
Rcho. Nuevo 2	Wildcat, San Diego del Mar., Veracruz	4-29	6550	Salt water.
Tlacolula 7	Wildcat, Frac. A, Tlacolula, Veracruz	6-3	8317	50 b/d oil.
Tlacolula 8	Wildcat, Frac. A, Tlacolula, Veracruz	11-3	8986	Dry hole.
Tlacolula 9	Wildcat, Frac. A, Tlacolula, Veracruz	11-3	8340	Dry hole.
Poza Rica Area:				
Well 66	Lot 40, Poza Rica, Veracruz	3-7	7248	Junked hole.
Well 26	San Miguel Mecatepec, Veracruz	5-12	7313	Dry hole.
Well 71	Lot 34, Poza Rica, Veracruz	6-5	7404	1260 b/d oil.
Well 54	Lot 5, Poza Rica, Veracruz	7-3	7513	3100 b/d oil.
Well 62	Lot 36, Poza Rica, Veracruz	7-9	7306	3100 b/d oil.
Well 78	Lot 5, Poza Rica, Veracruz	8-28	7385	2700 b/d oil.
Well 73a	Lot 21, Poza Rica, Veracruz	10-4	7437	2200 b/d oil.
Well 80	Lot 33, Poza Rica, Veracruz	10-8	7516	2500 b/d oil.
Well 81	Lot 32, Poza Rica, Veracruz	10-8	7513	2500 b/d oil.
Well 79	Lot 18, Poza Rica, Veracruz	12-27	7480	3000 b/d oil.
Isthmus of Tehuantepec:				
El Plan 149	Veracruz	1-5	6235	155 b/d oil.
El Plan 123	Veracruz	1-14	6261	155 b/d oil.
Cuichapa 23	Acalapa, Veracruz	2-20	2152	45 b/d oil.
Sarlat 23	Wildcat, Macuspana, Tabasco	3-30	2454	Junked hole.
El Plan 141	Veracruz	3-16	7041	Non-commercial.
El Plan 145	Veracruz	4-5	6040	125 b/d oil.
El Plan 116a	Veracruz	4-7	6562	Non-commercial.
Cabritos 2	Wildcat, R. Rubio, Veracruz	5-31	1703	Dry hole.
El Plan 152	Veracruz	6-9	6079	230 b/d oil.
El Plan 148a	Veracruz	7-1	5689	144 b/d oil.
Comalcalco 2	Wildcat, Comalco, Tabasco	8-3	9842	Dry hole.
Sarlat 24	Wildcat, Macuspana, Tabasco	8-5	3120	Junked hole.
Cabritos 3	Wildcat, R. Rubio, Veracruz	9-10	3033	Dry hole.
El Plan 153	Veracruz	9-10	6233	180 b/d oil.
El Plan 155	Veracruz	9-10	6234	200 b/d oil.
El Plan 150	Veracruz	9-15	6234	150 b/d oil.
Acalapa 5	Wildcat, Veracruz	9-30	3937	180 b/d oil.
El Plan 151	Veracruz	10-15	6779	Dry hole.
El Plan 156	Veracruz	11-2	6250	180 b/d oil.
Tonala 114	Veracruz	12-9	3311	Dry hole.

Palestine Disturbances May Cause Rerouting of Oil Line

Palestine disturbances have brought about discussions which may decide the immediate future of Middle East Oil installations, particularly the projected pipe lines from Iraq and Arabia to the Mediterranean.

Long sections of Iraq Petroleum Company's 16-inch line which parallels the existing 12-inch line are already prepared for welding and ditching, but recent Arab-Jewish strife has rendered uncertain the throughput of the Consolidated Refineries Plant at Haifa.

Trans-Arabian Pipeline Company is reported to have informed the Syrian government that it will abandon the route through Syria unless the proposed agreement for a right-of-way is approved by March 1. The company might in these circumstances also cut out the Lebanon and abandon plans for the construction of a refinery at the port of Sidon. In this event it is possible that if the troubles in Palestine continue an approach might be made to Egypt to make the outlet of the pipe line in that country.

In Persia a Seven-Year Plan has been announced for the development of industry which includes the formation of a Persian government company for the exploitation of local oil resources. The plan awaits approval of the Majlis, and if approved the Iranian government proposes to exploit all possible oil areas of Persia outside the present Anglo-Iranian concession. Experts will be employed from Holland, Switzerland, and the Scandinavian countries, and after satisfying local needs Persia intends to sell surplus oil to the Soviet Union.

Iraqis Receiving Oil Industry Training in Great Britain

The first batch of Iraqis to be trained in Britain in various branches of the oil industry has now been selected. This is in accordance with the terms of the concession granted Basra Petroleum Company (Iraq Petroleum Company subsidiary). The company undertook to allocate £3000 a year to train Iraqis, and this sum has been accumulating annually since the signing of the agreement in 1938. The first group numbers 13 students, some of whom are already in Britain.

Dutch Well Has Show

Royal Dutch Shell has announced the discovery of traces of oil in an exploratory well at Delft in Holland. The show was found at 2400 feet and testing continued.

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Exploration Survey In Germany to be Financed by U.S. Military Government

The American military government will finance a geological and geophysical survey in the Bavarian Basin and other German sedimentary areas during the spring. Objective will be sufficient oil to save some of the present $50 million being spent on importing petroleum products into Germany.

Gen. Lucius D. Clay, the U. S. military governor, has announced that two seismic reflection survey units are to be imported from the U. S. Up-to-date geophysical instruments are not available in Germany, and it would take a German company at least two years to build this equipment, even if the raw materials were available.

The survey probably will be carried out on a pooled basis by a number of major Allied oil companies who already have investments in Germany and who will operate in the bizonal area by invitation of the U. S. military government and the British Control Commission. The survey will cover most of Bavaria from Ulm on the French zone border to Passau on the Danube, and south from Munich to the Austrian border. In addition, all present and potential oil areas in the British zone will be surveyed, including the areas around Hamburg, Hanover and in Schleswig-Holstein.

Crude production from the British zone of Germany in October, 1947, was 350,247.93 barrels, and the output of the refineries was 293,244.48 barrels. The refineries' own consumption was 59,463.93 barrels.

Production is still being hampered through lack of tires for heavy vehicles, and there is a shortage of coal as well as difficulty in getting labor for the rehabilitation of certain plants. Production of synthetic fatty acids and detergents by Fischer-Tropsch synthesis remains small due to shortages of coal and catalysts.

Bulgaria Nationalizes Oil Industry, Seizes Holdings

The Bulgarian oil industry has been nationalized in accordance with a decree published December 23. It was reported that Militiamen seized the installations of the Bulgarian Petrol Corporation but this has since been denied and it has been announced that shareholders will be compensated under favorable conditions.

The Bulgarian government has decided to exempt the foreign-owned Sofia Enterprises Oil Company from nationalization. However, the U. S. Minister, Donald R. Heath, has requested the Bulgarian government to reestablish the company's status quo as the installations at the Danube port of Rustchuk were being operated as though nationalized.

Australasian's Kariava Test Works Below 11,212 Feet

The Kariava test of Australasian Petroleum Company had reached 11,212 feet at the end of December. This achievement is a remarkable one under Papuan conditions and it is probable that the hole will be carried down to the capacity of the rig.

The program for 1948 includes three new tests. The first two with new rigs will be at Oroi near Cape Suckling southeast of Yule Island, and at Upoia 20 miles upstream from the mouth of the Vailala River. The next deep test will be at Hohoro near Orokolo.

Aruba Refinery Has Record Output for Second Month

The Lago Oil and Transport Company, Ltd., an affiliate of Standard Oil Company (N. J.), established a record high in the processing of crude for the second successive month at its Caribbean refinery at Aruba, Netherlands West Indies. Runs for December averaged 380,484 barrels per day, compared with 375,900 barrels per day in November.

The Aruba refinery also achieved a new one-day peak for crude runs, amounting to 434,750 barrels, in addition to its overall December record. The previous high for a single day's operations was reached in November when crude runs totalled 425,113 barrels. Large volumes of fuel oil are being shipped from Aruba to the U. S.

Production in East Indies At Half of Prewar Level

Royal Dutch Petroleum Company's production in the Netherlands East Indies is now at nearly half its prewar level in spite of the fact many fields are still in Republican hands. Monthly production of crude on the various Shell fields is as follows in metric tons:

Soerabaya area, 5000 (36,000 barrels); Tarakan area, 23,000 (152,950 barrels); Balikpapan area, 32,000 (230,400 barrels); Pladjoe area (Sumatra) 88,000 (684,640 barrels); British North Borneo, 213,000 (1,416,450 barrels).

Refining capacity is as follows: Soerabaya, 7000 (59,500 barrels); Tarakan, 0000* (000,000 barrels); Balikpapan, 32,000 (272,000 barrels); Pladjoe (Sumatra) 210,000 (1,785,000 barrels); British North Borneo, 126,000 (1,071,000 barrels).

Oil output from British Borneo was 1,850,000 tons (12,580,000 barrels) in 1947 against 800,000 tons (5,440,000 barrels) in 1938, and production for 1948 is expected to be 2,250,000 tons (15,300,000 barrels).

The Palembang, Sumatra refinery of Standard Vacuum Petroleum Mij. has started limited runs to stills with crude received from the company's field 80 miles away. It was expected the daily throughput in February would be 32,000 barrels a day and that the pre-war capacity of 48,000 barrels a day will be reached before the end of the year. In spite of great handicaps the reconstruction of the refinery and rehabilitation of the deep water terminal have been accomplished within a year.

Cut in Electric Power Blamed For German Production Drop

Increased cuts of electric current as a result of coal shortages were blamed for a further decline of production in German oil fields. The output in November amounted to 47,233 tons or approximately 329,058 barrels, about 3400 tons or 23,766 barrels less than in October. The problem of securing accommodations for workmen in the Emsland fields has not yet been settled, and the lack of labor is decisively hindering the technical development in the Emsland.

Bentheim gas field produced 5,400,000 cubic meters or approximately 190,620,000 cubic feet of gas.

German Oil Production in November

FIELDS	Tons	Barrels
Schleswig-Holstein-Hamburg		
Heide	4,363	30,497
Meckelfeld	135	944
Reitbrook	2,936	20,523
	7,434	51,964
Hanover		
Etzel	360	2,516
Steimbke	3,137	21,928
Hademstorf	313	2,188
Thoren	1,476	10,317
Wietze	1,857	12,980
Fuhrberg	3,294	23,025
Nienhagen	9,837	68,761
Eicklengen	1,156	8,080
Wesendorf	3,741	26,149
Eddesse	197	1,377
Oberg	415	2,901
Molme	458	3,201
Broistedt	285	1,992
Hohenassel	1,587	11,093
Calberlah, Gifhorn, Ehra, Others	202	1,412
	28,315	197,922
Emsland		
Emlichheim	5,464	38,193
Georgsdorf	2,435	17,021
Lingen	3,028	21,166
	10,927	76,380
Total Northwest Germany	46,676	326,265
Baden	557	3,893
Total Germany	47,233	329,058

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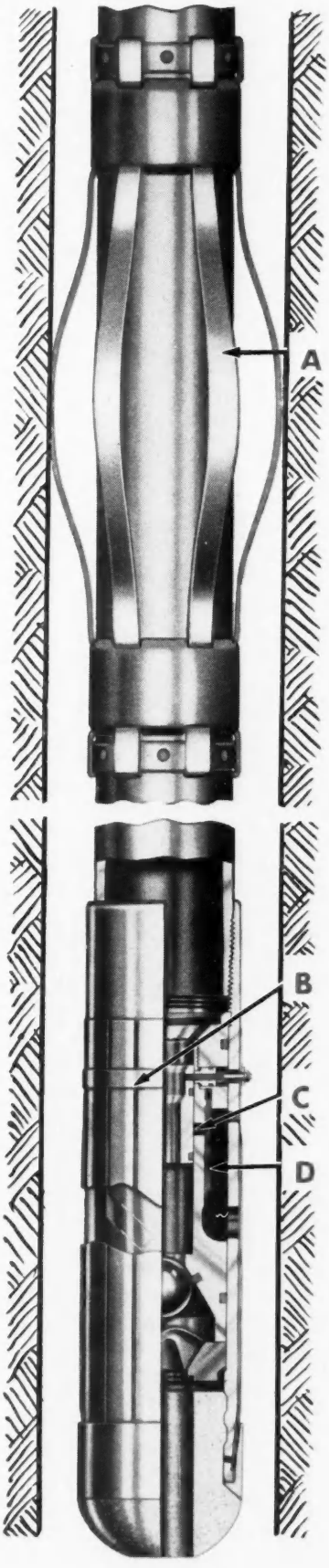


A Baker Casing Centralizers (Product No. 910) are installed on, and above, the shoe joint to center the casing and provide a uniform annulus to receive the cement slurry.

B A hold-down strap (secured by shear screws) retains the Baker Metal Petal Basket close against the shoe or collar while running-in the casing and conditioning the hole.

C Cementing ports are covered by the Tripping Valve until cementing is commenced.

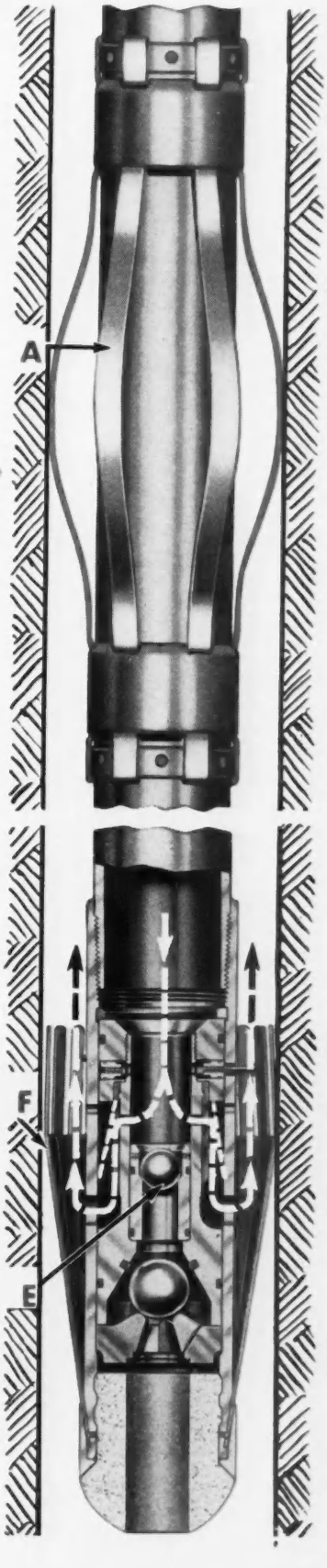
D A fabric-reinforced, resilient rubber, sleeve-type, back-pressure valve opens readily (see dotted white line) to permit passage of the cement slurry into the annulus above, but closes instantly to prevent any return flow of the slurry.

E After reaching the desired point in the hole, circulation is established through the ample central passageway. A Tripping Ball now is pumped (or allowed to gravitate) down the hole to seat upon the Tripping Valve. Pressure of 400 to 500 psi is applied to the casing, which shears the Tripping Valve shear screws and forces the Tripping Valve downward to expose the cementing ports.

F Shearing the screws also releases the Basket hold-down strap and allows the Metal Petal Basket to expand outwardly against the wall of the hole. The Basket with which each Triplex Shoe is equipped has a wide range of expansion and forms a bridge in large-diameter, or irregular-shaped holes far beyond the range of a rubber packing element.

The cementing operation now is carried out in the conventional manner with the cement slurry directed upward with the exclusive Baker "Whirler" action. This "Whirler" principle has proved to be far superior to an undirected jetting action which does not minimize the hazard of channeling, and may wash out cavities and cause cement contamination.

Only readily drillable materials are used for all internal parts; and two one-half inch set screws hold the inner assembly stationary to facilitate drilling out.



CEMENTING EQUIPMENT

Poland's November Output Fails to Show Increase

Crude production in Poland for November amounted to 81,133.6 barrels or a daily average of 27,039.6, which was almost the same as in the preceding month. The output of natural gas was 547,150,000 cubic feet and 4970 barrels of casinghead gasoline were obtained. Refineries produced 96,730 barrels of finished products and 3,187.8 barrels of greases.

A total of 7,983.5 feet was drilled for exploitation purposes and 6,458.3 feet for extending existing oilfields. Seventy-two wells were being drilled.

Detailed statistics now available for the period January to December, 1947, are as follows: Crude production, 95,000 metric tons (703,000 barrels); casinghead gasoline, 4939 metric tons (49,390 barrels); natural gas, 104,752,000 cubic meters (3,697,745,600 cubic feet); output of refineries, 131,000 metric tons (1,113,500 barrels); footage drilled, 35,436 meters (116,230 feet).

Russia Entrenching Position In Austria's Oil Industry

Discovery that the Russian occupying government in Vienna has been secretly engaged in construction of a cracking and hydroforming plant at Moosbierbaum, near Vienna, is believed to indicate that Russia means to take an active part in Austria's oil industry, and to minimize the chance that she will reconsider previous demands for two-thirds of Austria's oil production and reserves.

Construction on the plant, which will double Austria's output of gasoline, started in October and is expected to be completed in June, 1948. Hundreds of laborers, including displaced persons, are doing the work.

The plant will give the Russians approximately 480,000 barrels annually of 80 octane gasoline, useful for military and commercial vehicles and aviation. The plant's estimated total capacity is 900,000 barrels yearly.

Nearly all equipment was taken by the Russians from two hydroforming units built by the Germans in Moosbierbaum during the war. The units were not put into operation and the larger units was shipped to Russias as soon as Russian occupying forces controlled Vienna. A few leftover parts of this unit have been combined with the smaller unit and additional cracking furnaces bought from Czechoslovakia to construct the new plant.

Canada's Import Agreement With U. S. Is Continued

Canada's voluntary reduction in imports of fuel oil from the U. S. which has been in effect since January 1, will be continued until the end of April, the Department of Commerce announced through its Office of International Trade.

This action is the result of an agreement between the Canadian government and the Canadian oil industry. Under terms of the agreement imports from the U. S. of kerosine, gas oil and distillate fuel oil during the first four months of 1948 will not exceed 50 percent of the Canadian imports of these fuel oils from the U. S. during the same period of last year. Total Canadian imports from the U. S. of these fuel oils during the first four months of 1948 will not exceed 1,320,000 barrels.

The Canadian action in reducing its petroleum imports has been taken as the result of conversations between Canadian and American government officials in an effort to work out a solution to the petroleum shortage.

VISITORS AT HOUSTON NOMADS MEETING—Prominent foreign visitors at the February meeting of the Houston Chapter of Nomads were, front row, left to right: F. E. Abbott, Arabian-American Oil Company, Dhahran, Arabia; C. K. Suez, Chinese Petroleum Corporation, China; Tammio Noordhuis, Shell Oil Company, The Hague, Holland; M. N. Bien, Chinese Petroleum Corporation, China. Back row: Fred A. Hilton, Arabian-American Oil Company, San Francisco; Chas. E. Brown, Creole Petroleum Company, Maracaibo, Venezuela; Shelby R. Chambless, Hughes Tool Company, Barranquilla, Colombia.

IN A *Personal* WAY

F. D. Edwards has joined Trinidad Leaseholds, Ltd., and is now at Pointe-a-Pierre, Trinidad.

Sir Kenneth Brand Harper has been appointed a director of Shell Transport and Trading Company, succeeding **R. I. Watson,** who also was chairman of Burmah Oil Company. Watson died shortly after his retirement January 1 after 46 years with the company.

Thomas Duncan, surveyor of Kirkintilloch, Scotland, is leaving for Iraq to help in the building of a new town at Kirkuk for Iraq Petroleum Company.

H. A. Holmes has been elected chairman of the board of London and Thames Haven Oil Wharves, Ltd., in succession to **Lord Latham,** who has become chairman of the London Transport Executive.

Colonel Ted Masterson has resigned from the Phoenix Oil group and has joined the Head Office staff of Kuwait Oil Company in London. He was manager for many years of the Unirea Company in Roumania.

Sir Cecil Rodwell has resigned from the board of directors of Ultramar Company.

Herbert W. Rowbottom, general manager of the Anglo-Saxon Petroleum Company's Marine Department, is retiring after more than 40 years of service. He will be succeeded by **R. J. E. Dodds,** shipping manager.

C. Victor Barry has succeeded **R. W. Sellers** as European representative of Socony-Vacuum Oil Company with headquarters in London. He was petroleum attache at the American Embassy in London in 1945, and was also the American member on the British Oil Control Committee.

Sir Frederick Godber, chairman of the Shell Company, has received the Dutch decoration of Grand Officer in the Order of Oranje-Nassau, in recognition of his services to the Netherlands' cause during and since the war.

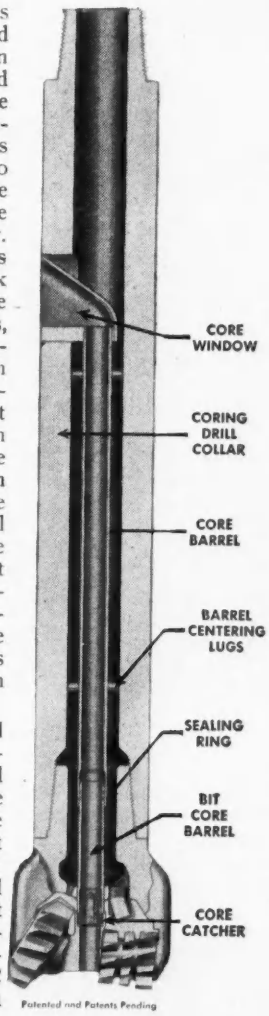
Hendrik Bloemgarten, vice president of Shell Oil Company, Inc., has been appointed a delegate member of the board of directors of the Bataafsche Petroleum Maatschappij.

E. J. Muller, general manager of Shell Nederland N.V. has retired after 35 years' service with the Shell group. He is succeeded by **H. van Drimmelen.**

NEW EQUIPMENT and Literature

1—Coring Bit

A coring bit has been developed that can be run continuously and does not require auxiliary equipment. It consists essentially of two main parts, the coring bit and the coring drill collar. The coring bit is a modified rock bit with the same large bearings, heavy construction and tooth pattern. It contains a fixed short core barrel which extends from the core opening in the bridge to the end of the tool joint pin on the bit. This short core barrel contains a spring-type floating core catcher which is retained within the barrel.



The coring drill collar has an outside diameter and bore the same size as that of the standard tool joint connection for the bit. It is produced with a tool joint pin-up and box-down and is generally furnished 52 inches long from shoulder to shoulder. The drill collar retains the core barrel which is centrally located within the bore and is threaded into the core breaker cage near the top of the collar. The cage is a fixed part of the collar and is sealed off from the downward mud stream within the collar. It forms a lateral opening or core window between the core barrel and the space between the drill collar and the wall of the hole. The lower end of the core barrel has a socket connection which slips over the short, fixed section of the barrel located in the bit. When the bit is made up on the drill collar, a continuous core tube is formed.

Under normal drilling operations, the central core cut by the bit enters the core barrel and passes on out the core window. When the bit is worn dull or it becomes necessary to pull the pipe, a three-foot core of the formation remains in the barrel.

For additional information write Security Engineering Company, Inc., Whittier, Calif.

2—Portable Hydraulic Cranes

The Ruger hydraulic portable floor crane has recently been developed for the oil industry for heavy lifting and moving of equipment, both in shops, warehouses and in fields. The crane is particularly suitable for repairing servicing hoists, portable drilling rigs, trucks and automotive equipment. It also is suitable for loading and unloading heavy equipment.

The new cane, by means of hydraulic pump and power cylinder actuates the cantilever arm and lifting hook. It is a highly compact, yet powerful and simple portable crane which can be moved to any part of the shop, either empty or with a suspended load. The lifting is done with back-and-forth strokes of the convenient waist-high operating lever. Lifting range extends from floor level up to 125 inches; and the extension boom adds another 42 inches to the total lift.

To lower the load, it is necessary only to open the release valve alongside the operating handle. Lowering is smooth and under positive control. The overall width is less than 35 inches, permitting the crane to work in narrow aisles and through ordinary doorways. The crane moves on large roller-bearing wheels. A heavy overload factor of safety permits the crane to carry nearly four times the capacity. The cranes are available in one- and two-ton; also in one-ton for truck mounting.

For additional information write the U. S. Equipment Company, 41 San Jacinto Street, Houston.

3—Liquid Level Indicator

Sonolog is an instrument for the acoustic determination of the liquid level in the annular space between the casing and tubing of an oil well. A small pressure-tight chamber attached to a casing outlet at the surface contains a microphone and a mechanism for firing a blank cartridge. Sound of the explosion travels down the annulus and is reflected almost totally at the top of the liquid column. The initial explosion and all reflected pulses are transformed into an electric current which is amplified and recorded on a moving strip of paper.

The instrument is designed for portable operation and consists of three major components: (1) well-attachment weighing 30 pounds; (2) amplifier recorder weighing 50 pounds; and (3) power converter weighing 15 pounds. A six-volt battery supplies the required power.

For additional information write Keystone Development Corporation, 2813 Westheimer Road, Houston 6.

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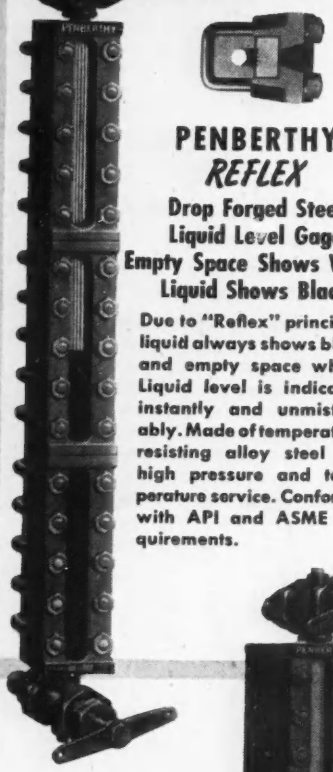
REFLEX and TRANSPARENT
DROP FORGED STEEL LIQUID LEVEL GAGES



PENBERTHY
REFLEX
Drop Forged Steel
Liquid Level Gage
Empty Space Shows White
Liquid Shows Black

Due to "Reflex" principle, liquid always shows black and empty space white. Liquid level is indicated instantly and unmistakably. Made of temperature resisting alloy steel for high pressure and temperature service. Conforms with API and ASME requirements.

PENBERTHY
TRANSPARENT
Drop Forged Steel
Liquid Level
GAGES

Glass front and rear permits observation of color and density of liquids under high pressures and/or temperatures. Highest quality—made of temperature resisting alloy steel. Conforms with API and ASME requirements.

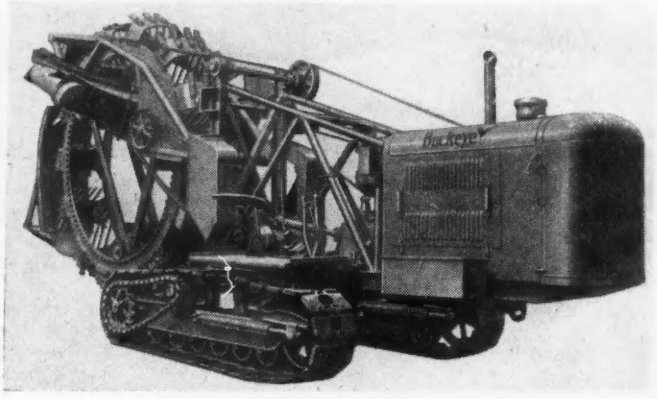
3277-C

PENBERTHY PRODUCTS

PENBERTHY INJECTOR CO.
Detroit 2, Mich.
Canadian Plant—Windsor, Ontario

NEW EQUIPMENT LITERATURE

4—Pipe Line Ditcher

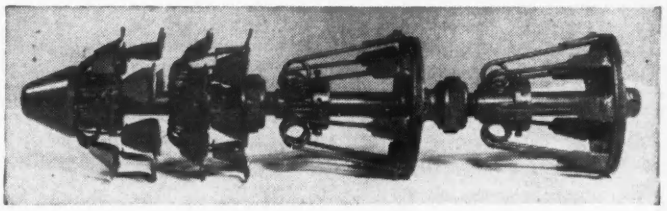


Structural progress of recent years, plus long and valuable ditch digging and pipe lining experience, have been embodied in the new Buckeye Model 312 Ditcher. It is said to be suitable for gathering lines, short loops, small product and gas lines and for work around tank farms, refineries and terminals.

The ditcher cuts a ditch 16 to 30 inches wide and up to six feet deep. The digging wheel is supported by a rugged frame of tubular members; a design which has proved its advantages in aircraft construction. It is several inches shorter than previous models and 500 pounds lighter. Its diesel engine develops 67 horsepower at 1600 revolutions per minute. A fluid coupling in conjunction with a friction clutch permits loads to be picked up or relieved with either or both. Digging speeds up to 57.5 feet per minute are provided. It has four forward and four reverse road speeds.

For additional information write Gar Wood Industries, Inc., Findlay Division, Findlay, Ohio.

5—Pipe Line Scraper



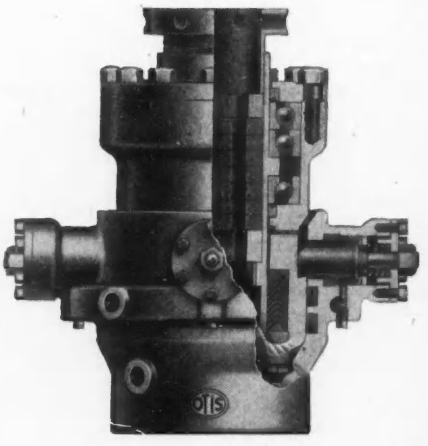
The Flex-O Pipe Line Scraper is designed to make two complete scrapings of the entire inter pipe walls as it passes through the line. Made of brass, aluminum and spring steel, the pipe scraper is available in sizes from four-inch, which is 24 inches long, to 14-inch, which is 48 inches long.

Outstanding feature of this scraper is its extreme flexibility, permitting short radius bends. It is self centering, and provides equal pressure on full pipe circumference. There are no rotating parts in the scraper, and the contact points of the scraping elements are hard faced for long life. The scraping knives on the larger size models are interchangeable, the unit having two sets of oil tempered spring steel scrapers.

Minimum radius bend for the smaller model is 20 inches, while the larger model will accommodate a minimum radius of 42 inches. Specifications on sizes up to 30 inches are available.

For additional information write Carver-Stimpson Pipe-Cleaning Company, 206 East Nebraska Street, Walters, Okla.

6—Drilling Head



The new type "D" Otis drilling head and pressure operated union is adaptable to high-pressure drilling operations, especially in the field of reverse circulation. Designed to operate safely up to 1500 pounds per square inch mud pressure, the hookup can be used in reverse circulation or conventional drilling; for drilling in or cleaning out under pressure; for blowout prevention; and for carrying excess pressure on the mud column. It is operated by a remote control pressure manifold placed at a convenient spot on the derrick floor, thus eliminating the necessity of men working under the floor during drilling operations.

The drilling head permits rapid coupling and uncoupling, maintains a constant seal around a square or hex kelly, and remains on the kelly during the entire drilling operation. For additional information write Otis Pressure Control, Inc., Box 7206, Dallas.

PERMANENT RESILIENCE

Resilient parts made from HYCAR synthetic rubber *stay* resilient. That's partly because of HYCAR's unusual chemical stability—its resistance to oil and gas, acids and most other chemicals. And parts made from HYCAR are extremely resistant to the effects of oxidation, sunlight, and normal aging. A HYCAR sealing ring, for example, will maintain a positive seal through years of service even when constantly exposed to oils and acids inside the pipe, and sunlight and salt air outside.

Other unusual and valuable properties are listed in the box at the right. But most important, these properties may be had in an almost limitless number of combinations, each designed to meet the specific service conditions of the finished part. Parts made from HYCAR have seen service in *every* industry, giving long life, dependability, and economical operation.

That's why we say ask your supplier for parts made from HYCAR. Test them in your own applications, difficult or routine. You'll learn for yourself that it's wise to use HYCAR for long-time, dependable performance. For more information, please write Dept. HP-4, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio.

WHAT HYCAR DOES IN OIL FIELD APPLICATIONS

1. *Resists oil and gas—even under high pressures and temperatures.*
2. *Resists action of abrasive-laden fluid under high pressure and at high velocity.*
3. *Wears at slow rate even under worst conditions.*
4. *Makes a positive, leak-proof seal, even after a long period of service.*
5. *Provides high elasticity.*
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7. *Has minimum tendency to cold flow and compression set.*

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American Rubber

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GEON polyvinyl materials • HYCAR American rubber • KRISTON thermosetting resins • GOOD-RITE chemicals

7—Anti-Acid Lubricant and Compound

Masters anti-acid lubricant is a high-grade lubricant especially compounded for severe chemical service. It has been tested under practical operating conditions servicing tank cars of sulphuric acid, where packing glands were packed at least twice a month and are now being packed once every two or three months.

It will effectively prevent seepage of acid into the working parts of pumps and handling equipment. As a reinforcing agent, it will increase the efficiency of the lubricants in present acid packings. It can be applied as a coating or film to all metal surfaces and provide positive protection against direct acid attack or from the corrosive action of vapors. If the can is placed in boiling water for several minutes, the compound will liquefy and can be brushed on metal surfaces of extended areas. Masters anti-acid lubricant is entirely unaffected by inorganic acids or mild caustics.

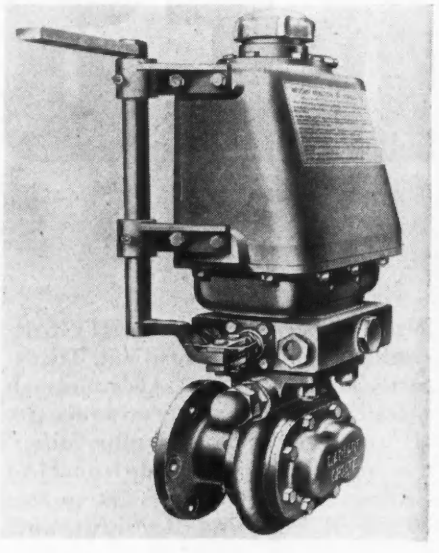
Masters metallic compound is a thread dope that remains plastic and is insoluble in water, steam, high octane gasoline and hydrocarbons, solvents, gases, vapors, and alkalis. It was developed to protect threads in all types of service to prevent them from bonding or galling so that after extended service the nut may be removed without difficulty. A babbitt-like film is deposited on each thread, no matter how fine, thereby fully protecting the metal surfaces as well as aiding the grip of the nut.

For additional information write James K. Harbinson & Company, Inc., 408 Root Building, 70 West Chippewa Street, Buffalo 2.

8—Hydraulic Products

A new line of hydraulic products, including hydraulic pumps, motors, valves, cylinders and a compact three-in-one power unit, is offered by LaPlant-Choate.

Pumps, motors, and power units are

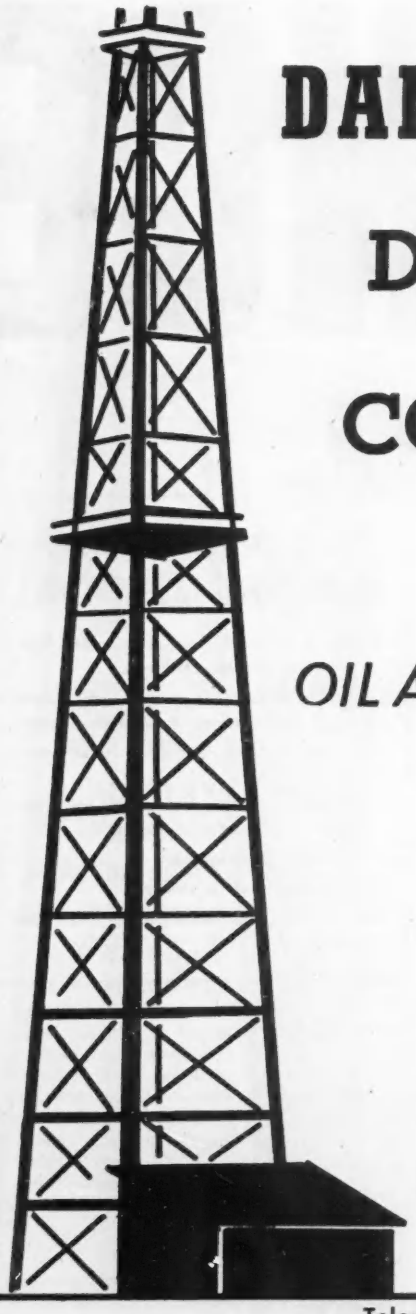


available in four sizes: 15, 25, 40 and 60 gallons per minute. Cylinders are available in three sizes: 4-, 5- and 6-inch diameters. Valves come in two sizes—for control of flows up to 50 and 70 gallons per minute.

Pumps and motors include such design features as interchangeable spur-type gears, needle roller bearings, positive lubrication, and bronze reversible thrust plates. The pumps are designed for automotive, portable or stationary installations and may be electric motor or engine driven. The power unit incorporates some revolutionary principles such as surge control, a supercharged pump and small capacity reservoir. Valves are spool-type, three positions (float position optional) and self-centering and may be had with or without automatic surge control. Cylinders are double acting and can be mounted in any position. Pistons are ring-type for high pressure sealing with piston rods chrome plated.

For additional information write LaPlant-Choate Manufacturing Company, Inc., Cedar Rapids, Iowa.

DAN L. CLARK W. M. AVERILL RUPERT COX



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Announcing ATLAS GUNS

The new ATLAS Perforating Gun has already proved in the field the following characteristics:

1. **Maximum penetration**
2. **Maximum number of shots**
3. **Maximum precision in the placing of bullets**
4. **Maximum safety**

The ATLAS Gun has a relatively small diameter, 3⅝ inches, and, therefore, can be used safely in all casings from 5 inches OD up. It is, however, a very powerful gun. Controlled tests under pressure and temperature show penetration of three casings or better.

The regular ATLAS Gun is a **45-shot** gun. For large operations, the number of shots can be increased to 63 per run.

The spacing of the bullets is only 2 inches (at a 90° angle). **Without moving** the gun, the operator has the choice of shooting 2, 4, **or** 6 shots per foot.

Several safety devices make it impossible to fire the ATLAS Gun accidentally.

ATLAS WELL SERVICE CORPORATION

P. O. Box 4042 **Houston 14, Texas**

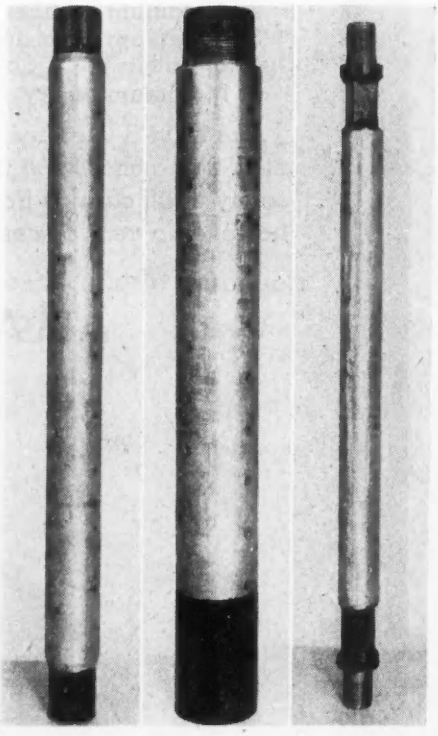
TELEPHONE: K. 3-5514. If No Answer Call: M. 2-5835, V. 4-2038

9—Electrolysis Arrester

Costly repairs and wasteful downtime resulting from corrosion or electrolysis of oil well pumping equipment can be entirely or substantially reduced with "Don" arresters. These stray electrical currents that are responsible for corrosion and subsequent failure of equipment are attracted to and neutralized by these arresters.

Electrolysis in oil well pumping rods is reduced by a casting of high-purity, expendable, negative metals encasing a two-foot section of API pony rod (pin to pin). The number and spacing of these arresters in the string are determined by the severity of corrosion. When only a relatively small amount of corrosion occurs in the pump, one arrester is sufficient. Where corrosion exists throughout the entire rod string, arresters are spaced according to well conditions.

Where severe corrosion occurs at the bottom of the pump, this arrester can be used, and is so designed as to be applicable to insert pumps. In extreme cases, the pony rod arresters are used in combination with the gas anchor arresters. To combat tubing corrosion, the tubing arrester is installed. It can be used in gas-lift or flowing wells.

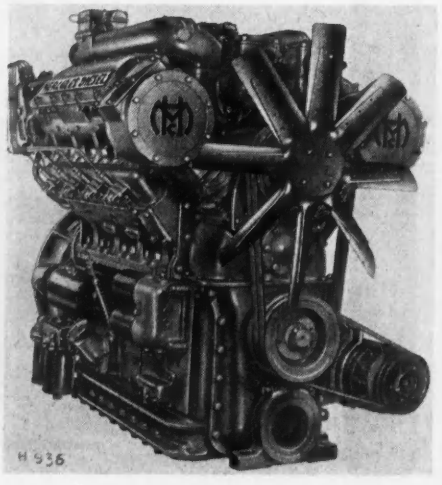


Although each arrester is designed for a specific application under various field conditions, this equipment is flexible and can be used in various combinations. Their proper application is said to eliminate or greatly reduce corrosion losses and costly repairs through electrolytic action.

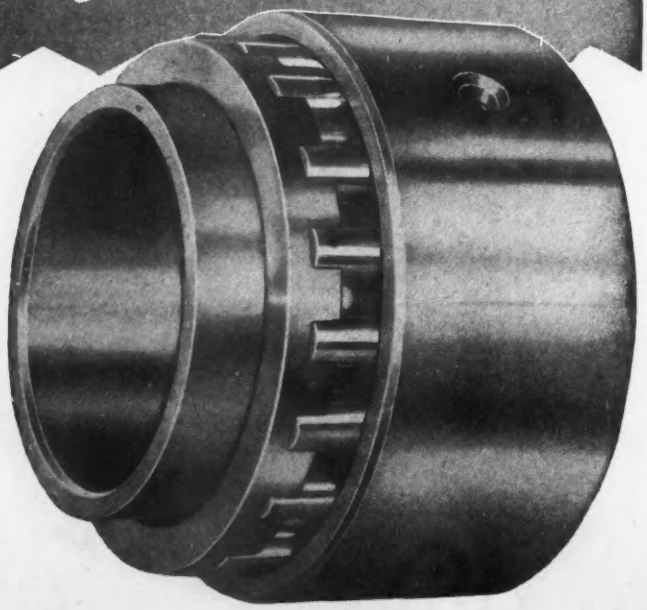
For additional information write Don H. Swindler, 1547 Castle Court Boulevard, Houston 6.

10—Diesel and Gasoline Engines

Development of six diesel and two gasoline engines of advanced design has been completed. Included in the diesel line is the Model DIX-6, a small six-



American
"Extra" Heavy-Duty
Roller Bearings
for the toughest anti-Friction jobs



Here is a "super" bearing designed especially for super heavy-duty service. Its simple construction, absolute precision and tremendous strength assure smooth, dependable performance in the heaviest machinery under the most difficult operating conditions. Complete technical data furnished without obligation. Write.

AMERICAN
ROLLER BEARING CO.
420 Melwood Street Pittsburgh, Pa.

AMERICAN ROLLER BEARINGS

Pacific Coast Office: 1718 S. Flower St., Los Angeles, Calif.

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And Regular Bailers

- **Thousands of MILLERS in use Throughout the World!**
- **The Standard Clean-out Tool!**

O. D. Sizes on MILLER SAND PUMPS are: 2½, 3, 3½, 4¼, 5, 5½ and 7 inches. Lengths are 20, 25 and 30 feet. The bail is welded to heavy seamless steel tube. Long heavy grooved plunger assures a liquid seal. Has three interchangeable bottoms. Wire line is direct connected to plunger—gives greater suction. DOES THE JOB! FAST! ECONOMICAL!

MILLER REGULAR BAILERS are made in 2½, 3, 3½, 4¼, 5, 5½ and 7 inch O.D. sizes and in 20, 25 or 30 foot lengths. Sectional Bailers made to your specifications. See Composite Catalog, page 2426, for prices, parts and details.

MILLER SAND PUMP CO.

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Export Office
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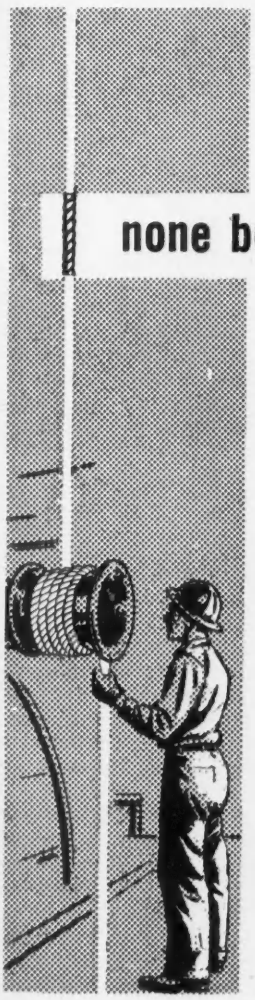

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none better for the oilman

• Proper Lay • Extra Strength • Special Treatments • Best Manila Available • Resistance to Weather • Ease of Handling

Every **NEW BEDFORD** manila rope —whether for cable tool lines, bull ropes, crackers, cat lines, torpedo lines, spinning lines, or any other oil field use—is made with an engineered lay. Soft or hard, the lay suits the rope use . . . adds flexibility . . . gives longer wear.

Proper lay is but one of six good reasons why **NEW BEDFORD** cordage is better for every use. All six are found in all **NEW BEDFORD** ropes.

FREE! Write today for handy booklet on knots, rope splicing and whipping.

NEW BEDFORD CORDAGE COMPANY

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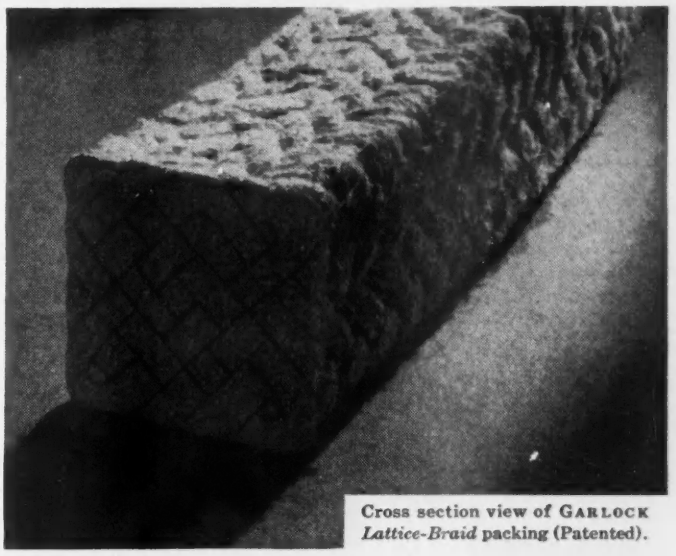
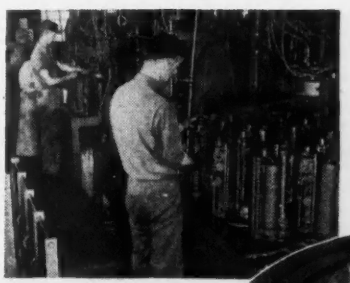


Cross section view of GARLOCK *Lattice-Braid* packing (Patented).

Lattice-Braided —for Longer Life

All the braided strands of GARLOCK *Lattice-Braid* packing are lattice-linked together into one structural unit. The strands hold firmly together even when the packing is worn beyond the serviceable limits of wear of ordinary braided packings. This unique structural design also provides unusual flexibility. GARLOCK *Lattice-Braid* packing is manufactured from asbestos, flax or cotton—for various types of service. Write for descriptive folder.

THE GARLOCK PACKING CO., PALMYRA, N. Y.
Tulsa, Okla. Houston, Tex. Los Angeles, Calif.



Specially designed braiding machines (exclusively Garlock) braid strands *through and through* in an entirely new and different way.

Right: GARLOCK 731 *Lattice-Braid* Coil.

GARLOCK *Lattice-Braid* PACKING

cylinder engine developing 93 horsepower with operating speeds at 3000 revolutions per minute. A four-cylinder diesel, Model DIX-4, is similar to the six-cylinder engine. The 3¼-inch bore and four-inch stroke engine develops 46½ horsepower at 3000 revolutions per minute. Stripped, it weighs 600 pounds. The postwar trend for flat, "pancake" type engines brought about the development of the Model DJXHF horizontal engine which produces 99 horsepower at 2600 rpm. A similar model with a 4½-inch bore and five-inch stroke develops 142 horsepower at the same speed. Its total weight is 1300 pounds.

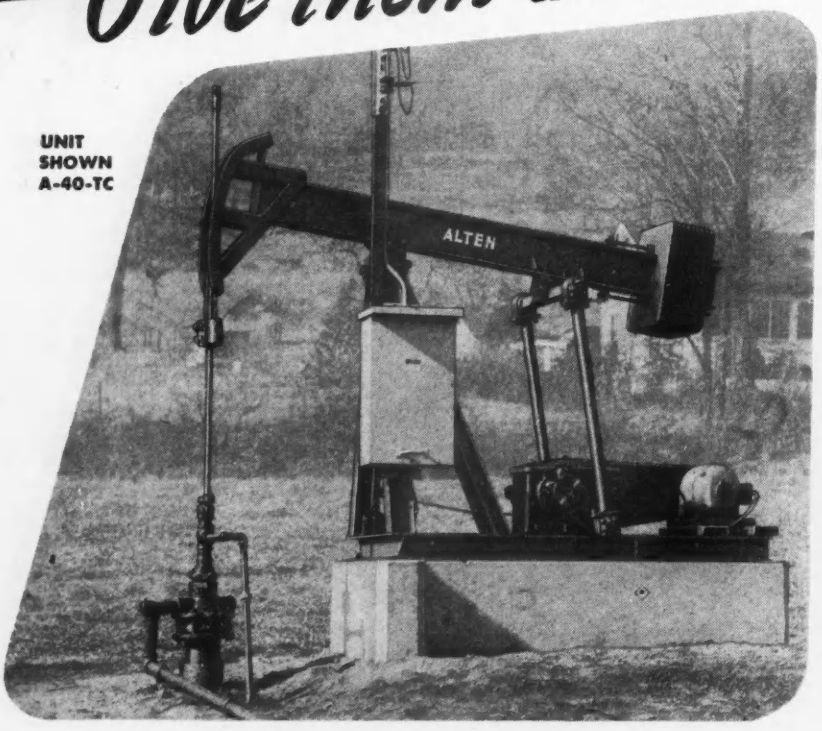
Illustrated is the V-8 series of diesel engines. These engines range in power from 340 to 400 horsepower at 2100 rpm, with piston displacement ranging from 1247 to 1468 cubic inches. This series is an outgrowth of a 32-cylinder diesel engine developed and built for the Navy during the war. Weight of the new model is 4200 pounds, and over-all length is 56½ inches. Where more power is required in special applications, a supercharged engine is offered which develops 500 hp at 2100 rpm. All the above diesel models are the solid injection, compression ignition, four-stroke cycle type. The combustion chamber is located at the side of the cylinder bore.

The two gasoline models are the TDXB and the RXYDH. The first engine is rated at 160 hp at 2600 rpm, has a piston displacement of 474 cubic inches, and weighs approximately 1345 pounds. The Model RXLDH is another heavy-duty, high-speed gasoline engine. Piston displacement is 558 cubic inches. At 2600 rpm, the engine develops 180 hp. Weight is 1470 pounds.

For additional information write Hercules Motors Corporation, Canton, Ohio.

ALTEN PUMPING UNITS

Give them a trial!



UNIT SHOWN A-40-TC

Quality Features Include:

★ High Capacity Double-Reduction Gear Reducer Chrome-Nickel Steel Pinions. Hardened Steel Gears. Helical Shaved Gearing. Roller Bearing Equipped Throughout.

★ Double-Row, Spherical Self-Aligning Wrist Pin and Equalizer Roller Bearings.

★ Rigid, All-Welded, Structural Steel Samson Post and Frame

★ Adjustable Stroke Lengths, Effective Balancing, For Use With Gas Engine or Electric Motor.

★ High Efficiency. Weatherproof Construction.

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Complete Pumping Unit Specifications. Also illustrates Alten Casing Heads, Stuffing Boxes, Stop Cocks and hundreds of other production items.

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FOUNDRY AND MACHINE WORKS, INC.
LANCASTER, OHIO
Established 1889
Sold Through Dealers Everywhere

11—Plug Valve

"Hydro-Lube" is a lubricated plug valve developed and proven during the war. Incorporating many innovations in plug valve construction, it is designed to provide positive circulation of the lubricant. Every time the valve is

opened or closed, all contact surfaces are lubricated by hydraulic force. The lubricant system is so arranged that the lubricant ducts are never exposed to the line flow, thus producing considerable saving in operating costs by using a minimum amount of lubricant.

"Hydro-Lube" is said to require no gaskets or stuffing boxes. The plug can never leave its seat in the body, being securely held by a bushing in the bonnet. This eliminates any chance for the line flow to pass between the plug and body of the valve.

These valves are made in sizes from one to four-inch screwed end and one by four-inch flanged end for 175 pounds water, oil or gas pressure. Additional sizes are scheduled for production later.

For additional information write Pittsburgh Valve and Fittings Corporation, Barberton, Ohio.

THOMPSON-HAYWARD
FORMALDEHYDE
for corrosion control

You can protect your casings, rods, and all exposed metal parts for only a few cents a day. You can

- SAVE ON PULLING COSTS
- SAVE ON NEW STEEL
- SAVE ON SHUTDOWN TIME

Thompson-Hayward Formaldehyde gives dependable protection from hydrogen sulphide corrosion and corrosive mine and well waters.

Write our nearest office for detailed information

THOMPSON-HAYWARD CHEMICAL CO.

Dallas, Houston, Denver, Wichita, Tulsa, San Antonio, New Orleans

(B)

"I'll take the WHITE one every time!"

WYTEFACE "A"
Trade Mark
Steel Tapes for the Oil Industry

WYTEFACE "A" Steel Tapes have raised black graduations on a crack-proof white surface. Easy to read in any light, from any angle. Designed for hard service. Resist rust and corrosion. Raised rims and markings protect the white background from abrasion from rails, pipe, rocks, concrete. Made in styles especially for Oil Riggers, Oil Gaugers and for general measurements. See your supply house, or write for details to Keuffel & Esser Co., Hoboken, New Jersey.

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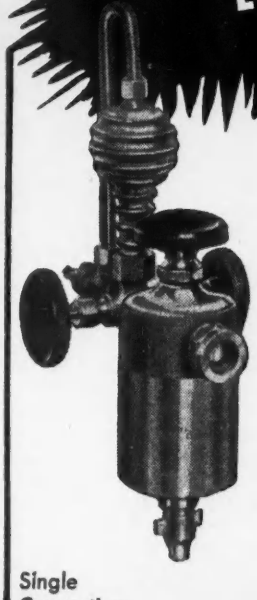
Drafting, Reproduction, Surveying Equipment and Materials, Slide Rules, Measuring Tapes

STEAM CYLINDER LUBRICATORS



Single Connection

SWIFT LUBRICATORS

For years have been widely used by the oil producing and refining industry for cylinder lubrication on steam-driven slush pumps, boiler feed pumps, drilling engines and other similar equipment.

Simple, dependable and inexpensive, Swift Lubricators are especially suitable for use in cold, exposed weather service. The famous Swift bullseye sight-feed tells at a glance the rate of oil feed. This style of sight-feed eliminates leakage, repacking and glass breakage common with the tubular glass types.

Available in ½ pint, 1 pint and 1 quart sizes in both single and double-connection styles. Your supply house has them or can secure them for you.

SWIFT LUBRICATOR CO., INC.
27 Home Street, Elmira, N. Y.

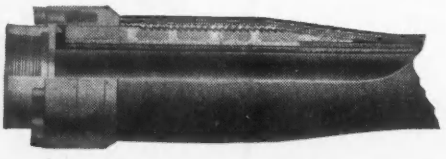
be ready to deal with
cavernous formations

When large crevices cause a loss of mud, be prepared with K-25 Fiber. These treated fibers are a valuable aid because they form a dense, felted mat of high sealing efficiency. Rigid quality control in the manufacture of K-25 Fiber assures you a uniform product with stable characteristics. K-25 mixes easily with mud—does not rot or disintegrate—stays in suspension until deposited. Find out why so many engineers recommend K-25 for dealing with lost circulation—write Wood Conversion Company, Dept. 201-38 First National Bank Building, St. Paul 1, Minn.

K-25 INDUSTRIAL FIBER

12—Rotary Hose and Coupling

Designed to meet the requirements of hard drilling conditions and high pump pressures are the Ray-Man rotary hose and the new built-in type "E" coupling. The hose is built on an entirely new principle made possible by a special made machine that winds high tensile steel wire hose strength members under precisioned tension. According to the manufacturer, this method produces a hose with five important advantages that include super-flexibility, steadiness in the derrick because of resistance to pulsation under pressure, long life, easy handling with less danger of damage, and oil-proof synthetic flexlastics tube for all methods of drilling, including oil or oil-base drilling fluids.

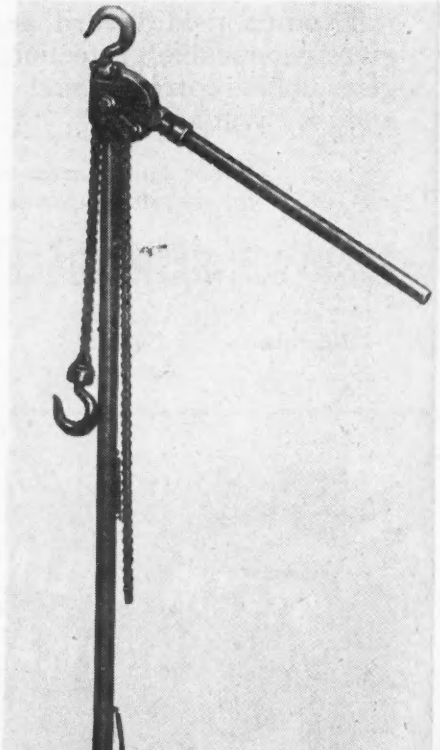


The streamlined built-in type "E" coupling features the new "Lip-Lok" pressure sealing flange and embodies added safety and assurance against costly leaks and blow-outs.

For additional information write Raybestos-Manhattan, Inc., Manhattan Rubber Division, Passaic, N. J.

13—Hoist Jack

The new Hoist-Jack is a combination hoist and jack designed to move or lift heavy loads. Complete in only three pieces (stand, hoist and handle), the instrument has a rated capacity of 2000 pounds, yet weighs only 23 pounds complete.



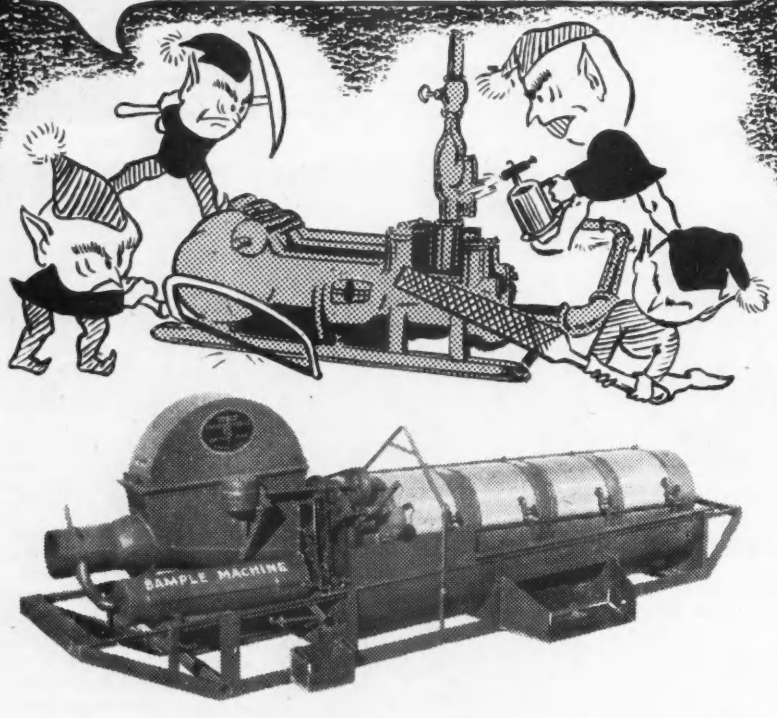
It features a hoist whose ratchet-and-pawl construction uses the smallest possible number of working parts; a "safety-load" handle designed to bend at maximum overload before there is any possibility of the chain breaking or of hooks straightening out; a stroke (which, at the top, brings the handle to a level just even with the top of the hoist frame horizontally) raises or lowers the load (thus requiring very little headroom), and is so compact that when taken apart is can easily be carried in a tool box. By mounting the hoist unit on the stand (which takes only a few seconds), a sturdy, powerful jack is obtained.

Weight of the hoist alone is 13 pounds. Height of the stand is 42 inches. Although the Hoist-Jack's rated capacity is one ton, it has been factory tested at two tons.

For additional information write Coffing Hoist Company, Danville, Ill.

"KILLER" SHALE SAYS:

TAKE YOUR LAST CUT AT THIS MUD PUMP, MEN --- THEY'RE PUTTING IN A THOMPSON SHALE SEPARATOR!



Don't let shale and abrasives shorten the life of expensive drilling equipment. A Thompson Shale Separator cleans and conditions drilling mud with complete efficiency... is 100% self-motivating... operates perfectly at maximum flow or idling. There are three sizes—ideal for shallow, medium and deepest wells. Thompson model "DWF" is made for the biggest mud pumps now in operation. *A special Thompson feature: attached* SAMPLE MACHINE provides accurate foot-by-foot samples of cuttings... quickly pays for the entire machine.

For complete information on all Thompson Separators, write for free illustrated folder.

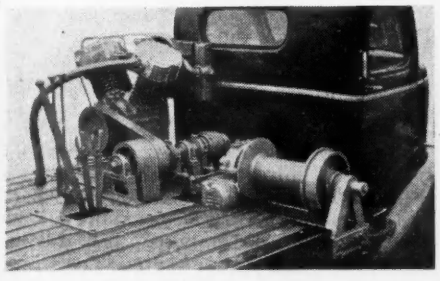
THOMPSON TOOL CO.
IOWA PARK, TEXAS

KEEPS DRILLING MUD CLEAN — PROVIDES *TRUE* SAMPLES OF CUTTINGS

NEW EQUIPMENT LITERATURE

14—Truck-Mounted Compressor

Recommended for pipe line construction and repair, for lease maintenance and general utility work is a new truck-mounted "Auto-Air" compressor-winch assembly. Power for operation of both



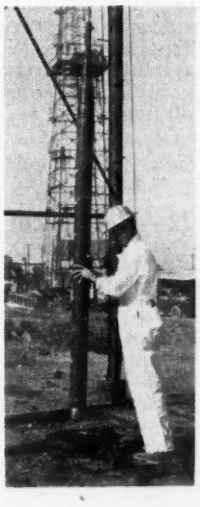
compressor and winch is transmitted from the truck engine by a Davey heavy-duty power take-off installed in the truck's driveshaft. Countershaft with two individual Twin Disc clutches provides for simultaneous or separate operation of compressor and winch. The compressor is a standard Davey Model 105-VC "Auto-Air." It delivers 105 cubic feet per minute at 100 pounds pressure. The winch has a pulling capacity of 25,000 pounds.

Air receiver and double hose reels are mounted beneath the truck platform. The unit extends only 40 inches behind the truck cab.

For additional information write Davey Compressor Company, Kent, Ohio.

15—Jet Perforating

The new jet process for casing perforation is particularly valuable where greater formation penetration is required. The jet process may be used in any well where gun-perforating is used. Tests have shown that jet-perforating penetrates through the heaviest casing, cement and deeply into the formation. There is no bullet and the casing is not split or bulged. Jet perforating is said to operate effectively at well temperatures up to 350° F.



The jet process of casing perforating utilizes the principle of the shaped explosive charge. The charge weighs less than one ounce, and upon detontation a high velocity jet is formed which is directionally controllable much the same as a bullet. Jets are fired electronically through ports in a steel carrier which is lowered into the well on a wire line unit. Ports are spaced on three-inch centers or greater, at 120 degrees and are sealed to exclude well fluids and pressures.

For additional information write Well Explosives, Inc., 3909 South Hemphill, Fort Worth.

Here are Hooks that hoist your Profits!

Clevis Hoist Hook Is Quickly Attached . . . Changed . . . Saves Time and Labor. Slip the bolt through the clevis, spin the nut, spread the cotter and this heat-treated hook's ready and safe for your toughest jobs. No welding, no spelter, no connecting fittings required. Send for Laughlin's famous data book of industrial fittings...Catalog No. 140.

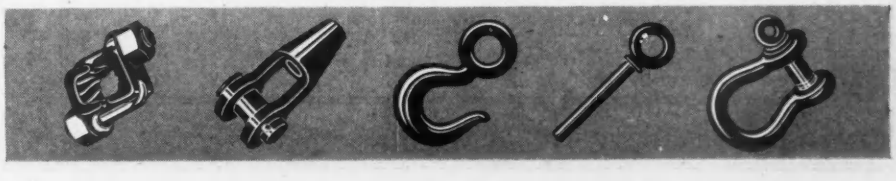
THE THOMAS LAUGHLIN CO., DEPT. 23, PORTLAND 6, MAINE.

Laughlin Safety Hook . . . "The Latch Locks The Load" . . . adds a big safety factor to every lift. Sturdy latch, stainless steel spring. For every industrial application.

Laughlin Replacement Swivel Hook Assembly with Safety Latch. Bolts on and off . . . no machining . . . no threading. For hoists, cranes, lashing operations. One-ton and half-ton sizes.

LAUGHLIN

THE MOST COMPLETE LINE OF DROP-FORGED WIRE ROPE AND CHAIN FITTINGS



16—Steam Jet

"Steam Jet Ejectors," Catalog 1462, contains 36 pages, 30 sectional drawings, flow diagrams, engineering data installation guides, formulae, curves and tables relative to steam ejectors. It covers the theory and operating characteristics of steam jet ejectors for all classes of vacuum service, including single, 2, 3, 4, and 5-stage types. Non-condensing and condensing types, with barometric inter-and-after-condensers for vacuum requirements are fully covered. It also contains information regarding steam jet vacuum refrigeration for water-cooling requirements of air conditioning and process applications.

C. H. Wheeler Manufacturing Company, Gratz & Sedgley Avenues, Philadelphia.

17—Reflectogage Data

The operation and applications of the Sperry Reflectogage, for thickness measurement and the inspection of bond, are completely described in Technical Data Sheet 3700.

Sperry Products, Inc., 1505 Willow Avenue, Hoboken, N. J.

PARKERSBURG MACHINE Co
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PARKERSBURG, W. VA., U.S.A.

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Exclusive Export Distributor:
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30 Rockefeller Plaza, New York 20, N. Y.

18—Pipe Line Equipment

A four-page folder punched for loose leaf binding presents information on internal alignment clamps for pipe line welding (both hand operated and electric) expanders and portable power uits. All units are illustrated.

M. J. Crose Mfg. Company, Inc., 2715 Dawson Road, Tulsa.

19—Mud Additive

A pocket-size booklet presents introductory information on Aerotan, a drilling mud additive for the control of water losses. What the material does, its specifications, methods of use, advantages and applications are briefly set out. It is bound in heavy paper.

American Cyanamid Company, 30 Rockefeller Plaza, New York 20.

20—Larkin Catalog

Price listings, illustrations and descriptions of the entire line of Larkin cementing and production equipment are included in a general catalog. Neatly bound, the catalog provides a handy reference for field and supervisory personnel as well as for purchasing departments.

Larkin Packer Company, Inc., St. Louis.

21—Centrifugal Pump

Bulletin 47-8020 describes the Hydroplex Pump, a split case multi-stage centrifugal pump for low capacity and high pressure pumping. Eight pages in two colors cover various views of the Hydroplex, cross-section schematic, subassemblies, parts and dimensional orthographic drawings, and also installation photographs.

Byron Jackson Company, Pump Division, Los Angeles 54.

22—Mechanical Rigs

"Oilwell Mechanical Rigs" is the title of a booklet describing the No. 96 drawworks, No. 1000 dual and triple-engine drives, No. 64-B drawworks, No. 500 dual-engine drive and the "Oilwell"-Brantly hydraulic feed control. Many features are described that are not yet known to the industry. The two-color booklet contains many photographs. Engineering drawings give dimensional data as well as illustrate layout of the equipment.

Published by Oil Well Supply Company, Dallas 1.

23—Air Filter

An eight-page booklet explains the operation and application of the Multi-Duty self-cleaning air filter for engine and compressor service. Installation photographs as well as detailed engineering data are included in Bulletin 150.

American Air Filter Company, Inc., 215 Central Avenue, Louisville.

Associations

Mid-Continent Oil, Gas Group Plans Tax Forum April 27-28

The annual Federal Tax Forum of the Mid-Continent Oil & Gas Association will be held at the Blackstone Hotel, Fort Worth, April 27-28, it was announced by E. E. Hunter, Humble Oil & Refining Company, Houston, and M. J. Lasseigne, Arkansas Fuel Oil Company, Shreveport, chairman and vice chairman of the forum.

Hunter said "the agenda of the forum will cover a review of developments in federal tax matters during the past year, as well as discussions of current federal tax problems of special interest to those oil company tax representatives who are engaged in the federal tax field."

Other members of the Executive Committee of the Association's Standing Committee on Federal Taxation, which annually sponsors the forum, arranges its program, and supervises its agenda, are James E. Allison, Warren Petroleum Corporation, Tulsa; W. Leo Austin, Mid-Continent Petroleum Corporation, Tulsa; Ira M. Avent, United Gas Pipe Line Company, Shreveport; Chas. R. Bell, Kerr-McGee Oil Industries, Inc., Oklahoma City; L. W. Bennett, Sunray Oil Corporation, Tulsa; Paul R. Bishop, D. R. Lauck Oil Company, Inc., Wichita; F. J. Blaise, The Pure Oil Company, Chicago; D. R. Boggs, Standard Oil Company of Texas, Houston; J. E. Bounds, Gulf Oil Corporation, Tulsa; H. H. Boyer, Sun Oil Company, Dallas; Geo. D. Brabson, The Ohio Oil Company, Findlay; R. W. Clark, Skelly Oil Company, Tulsa; Riley Frick, Tide Water Associated Oil Company, Tulsa; J. B. Galbraith, Stanolind Oil and Gas Company, Tulsa; V. G. Gillingham, The Texas Company, Houston; S. M. Greenidge, Texas Pacific Coal and Oil Company, Fort Worth; S. R. Harwell, Magnolia Petroleum Company, Dallas; H. D. Mahin, Phillips Petroleum Company, Bartlesville; T. H. Marshall, Anderson-Prichard Oil Corporation, Oklahoma City; O. W. Meyers, Sinclair Prairie Oil Company, Tulsa; Hilary M. Norman, Standard Oil Company (Ohio), Cleveland; F. B. Plank, Cities Service Oil Company, Bartlesville; E. P. Potter, Amerada Petroleum Corporation, New York; H. F. See, The Atlantic Refining Company, Dallas; D. L. Shepherd, Union Oil Company of California, Los Angeles; Ralph E. Smith, The Superior Oil Company, Los Angeles; T. J. Thurman, The Carter Oil Company, Tulsa; E. A. Vaughey, Vaughey and Vaughey, Jackson; R. M. Walton, Shell Oil Company, Inc., Tulsa.

Building Under Way At Exposition Site

This air view taken February 1 shows many current construction projects now in work for the Silver Anniversary of the International Petroleum Exposition which opens May 15, 1948.

Major buildings or sites for new buildings are 1. Hall of Science. Exhibits from all parts of the world that help tell the "story of petroleum" will be housed here. 2. General offices and new international headquarters for Nomads Society. 3. New four-room hospital. 4. National Supply Company building, a new two-story structure now under construction. 5. Site of new Bethlehem Supply Company building. 6. General Motors Corporation building. 7. Chrysler Corporation building site. 8. Dresser Industries to erect new building here. 9. Silver Lane, new "white way" already flanked by 43 display booths. 10. Coliseum where many safety and other educational features of the exposition may be held. 11. Enlarged restaurant and cafeteria. 12. An additional 25 display booths recently completed. 13. New Hughes Tool Company building. 14. Jones & Laughlin building, recently enlarged. 15. Scientific & Technical building which will house hundreds of special exhibits. The new press and radio offices are located here. 16. Six smaller exhibitor-owned structures will soon be built here.

AGA Executive Board Pays Tribute to Percy S. Young

The executive board of the American Gas Association passed a resolution paying tribute to the place of leadership and distinction occupied by Percy S. Young during 57 years of active service in the public utility industry. Young retired as chairman of the Executive Committee of the Public Service Corporation of New Jersey and subsidiary companies on December 19.

After citing his outstanding business career which started in 1890 with the Omaha Gas Company, the resolution records Young's great contributions to the gas industry through national association work. He served as president of the National Commercial Gas Association in 1914 and represented that association on the committee which organized the American Gas Association in 1918. He was President of AGA in 1934, served on the executive board for 15 years, and for the past two years on the Advisory Council. He has served on approximately 30 committees covering a wide field of activity and as chairman of many of those committees.

Drilling Mud Training Classes Held in Louisiana Cities

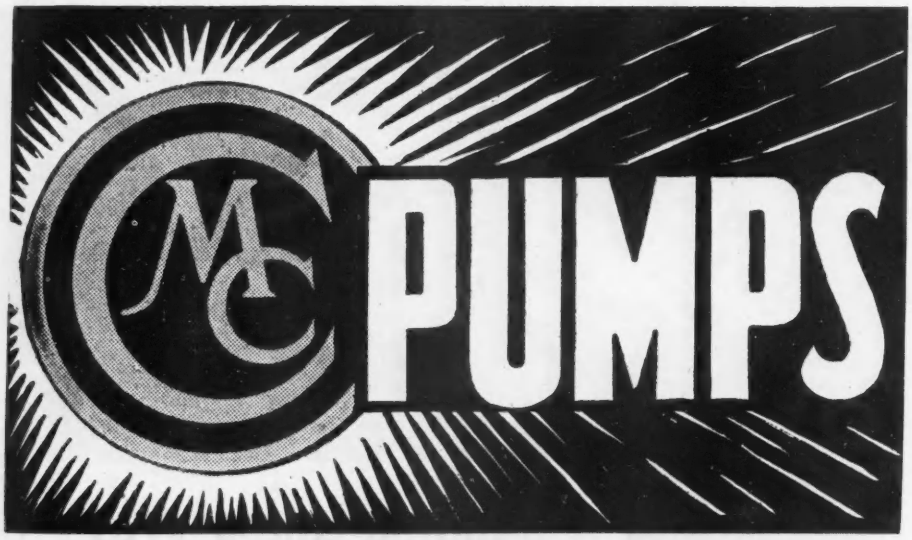
The industry-wide drilling mud training program sponsored and supported by the American Association of Oilwell Drilling Contractors since its beginning in June, 1946, at Kermit, Texas, and successfully conducted in eight oil-producing states, was recently extended to Louisiana.

Organized under the direction of Kye Trout, drilling mud specialist for the Extension division, The University of Texas, the first experimental classes were held at Lake Charles and New Iberia in December. A permanent committee composed of 18 members representing drilling, production and refining activities has been organized at Lake Charles to coordinate and supervise the training program. J. Geer Wilcox, vice president, Circle Drilling Company, is chairman; and W. D. Smith, Jr., chief engineer, Union Sulphur Company, is secretary-treasurer.

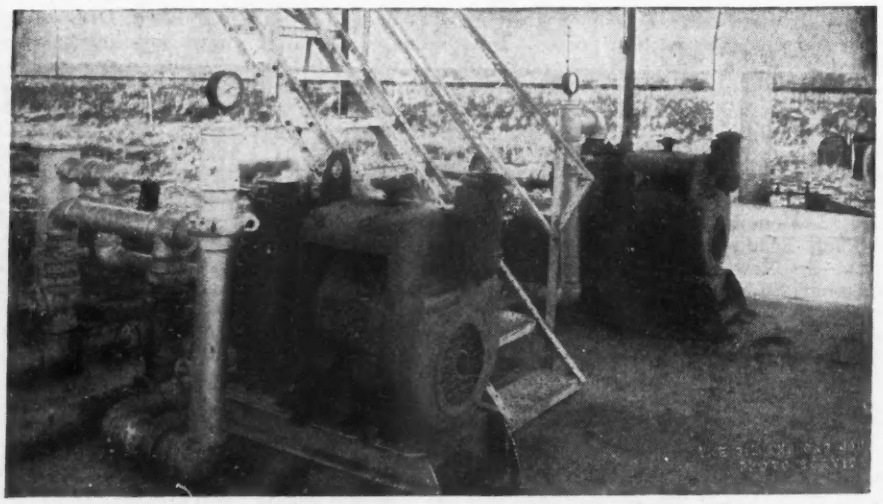
The Southwest Louisiana Trade School, Rex H. Smelser, director, has assumed responsibility for the administration of the field training program. James E. Conway, formerly with J. S. Abercrombie Company, has been appointed full-time field instructor.

Eleven schools have been tentatively scheduled for Louisiana during 1948 as follows: Houma, February 23-March 5; Harvey, March 8-20; Lafayette, May 3-14. Dates have not yet been set for schools at Monroe, Arcadia, Shreveport, New Iberia, Crowley, Lake Charles, Jennings and Hackberry.

The mud training program also will be extended into Mississippi where schools will be held at Natchez, April 5-16, and Jackson, April 19-30.



Utility Dual Prime **Model 420**
4" Pump — 20 H. P.



These two Model 420 Pumps loading Lub-Oil down in Texas is typical of the many services rendered by CMC Pumps for the oil industry. Ask our engineers to help you with your specific pumping problem.

CONSTRUCTION MACHINERY CO'S.

Specializing in High Pressure centrifugals, Dual Prime centrifugals and Diaphragm pumps for the oil fields.

WATERLOO, IOWA

1903 Blodgett St., Houston, Texas

TELEPHONE HADLEY 3988

Houston Purchasing Agents' Association Elects Officers

J. B. Thompson, purchasing agent for Shell Pipe Line Corporation, was elected president of the Purchasing Agents Association of Houston.

J. B. Thompson

Thompson, who succeeds Sam H. Harper, division purchasing agent of The Pure Oil Company, has been with Shell since 1923, when he joined the company as a trainee with the Engineering division of the Manufacturing Department. His purchasing experience started in 1929, at Shell's office in St. Louis, Mo.; and in 1934, he was transferred to Houston. Since that time he has served on temporary special assignments, including foreign service in the West Indies and South America, until 1940, when he was made purchasing agent for Shell Pipe Line Corporation.

Harper, who now becomes national director of the association, has been in the oil business since 1921 and with The Pure Oil Company for the past 26 years, 18 of which have been spent as division purchasing agent at Houston.

Other officers elected: C. S. Frank, of Dow Chemical Company, Freeport, first vice president; E. E. Graham of Reed Roller Bit Company, second vice president; James Cox of *The Southwestern Purchaser,* secretary; and W. J. Peddie of Maintenance Engineering Corporation, treasurer. W. R. H. Mau of Missouri Pacific Lines was elected alternate national director. Three local directors elected were R. T. Eaton of J. S. Abercrombie Company; R. J. Gallagher of Metal Goods Corporation; and C. L. Williams, Corbett Corporation.

Houston API Meets

"The Purchasing Agent's Viewpoint" was the theme of a talk by O. D. Story, chief purchasing agent for Shell Oil Company, Houston, at the monthly meeting of the Houston Chapter, API. He dwelt on the shortage of steel in oil field operations and the relationship between the Purchasing department and engineers.

THE OIL MAN'S CALENDAR

FEB. 15–19	American Institute of Mining and Metallurgical Engineers, Annual Meeting, New York, Pennsylvania Hotel.
16–17	Kansas Oil Men's Association, Annual Meeting, Wichita.
MAR. 9–10	Wisconsin Petroleum Association, Milwaukee, Schroeder Hotel.
12–14	Texas Independent Producers and Royalty Owners' Association, Annual Meeting, Corpus Christi.
24–26	Natural Gasoline Association of America, Annual Meeting, Ft. Worth, Texas Hotel.
24–26	Southern Gas Association, Galveston, Texas.
24–26	American Petroleum Institute, Mid-Continent District, Wichita Kansas, Broadview Hotel.
APRIL 5– 8	National Association of Corrosion Engineers, Annual Meeting, St. Louis, Hotel Jefferson.
6	American Association of Oil Well Drilling Contractors, Directors' Meeting, New Orleans.
6–7	Michigan Petroleum Association, Annual Spring Convention, Detroit, Detroit Leland Hotel.
8–10	Mid-West Gas Association, Annual Meeting.
14–16	American Petroleum Institute, Southwestern District Meeting, San Antonio, Plaza Hotel.
21–23	National Petroleum Association, Cleveland, Hotel Cleveland.
25–27	Independent Petroleum Association of America, Mid-Year Meeting, Wichita, Kansas, Broadview Hotel.
26–29	American Association of Petroleum Geologists, Society of Economic Paleontologists & Mineralogists, Society of Exploration Geophysicists, Annual Meeting, Denver, Shirley-Savoy Hotel.
27–28	Mid-Continent Oil & Gas Association, Federal Tax Forum, Fort Worth, Blackstone Hotel.
28–30	Liquefied Petroleum Gas Association, Annual Convention and Trade Show, Kansas City, Mo.
MAY 4– 5	American Gas Association, Natural Gas Department, Annual Spring Meeting, Houston, Rice Hotel.
6– 7	American Petroleum Institute, Pacific Coast District Meeting, Los Angeles, Biltmore Hotel.
15–22	International Petroleum Exposition, Tulsa.
27–28	Natural Gas & Petroleum Association of Canada, Niagara Falls, Ont., General Brock Hotel.
JUNE 6– 8	Petroleum Equipment Suppliers Association, Colorado Springs, Colo., Broadmoor Hotel.
JUNE 30 July 2	American Petroleum Institute, Eastern District Meeting, White Sulphur Springs, W. Va., Greenbrier Hotel.
JUNE 30 July 3	Canadian Gas Association, Annual Convention, Jasper, Alberta, Jasper Park Lodge.
SEPT. 15–17	National Petroleum Association, Atlantic City, N. J., Hotel Traymore.
OCT. 4– 9	American Gas Association, Atlantic City.
NOV. 8–11	American Petroleum Institute, Annual Meeting, Chicago, Stevens Hotel.

Nomads Chapter monthly meetings: **Los Angeles**, second Wednesday, Jonathan Club, B. M. Landis, Secretary. **Houston**, second Monday, Houston Club, Harry E. Estes, Secretary, Telephone Charter 4-7611. **Dallas**, L. A. Little, Secretary, Telephone Justin 8-1726. **Tulsa**, third Wednesday, Hotel Tulsa, Anthony Gibbon, Secretary, Telephone 3-1844. **New York**, first Monday, Louis Sherry's, Norris Boulden, Secretary, Telephone WIckersham 2-1311, extension 260.

A fine art

As recently pointed out in a Saturday Evening Post editorial, "We tend to correct people if they are wrong, even if we have to pass a law to do it. At the very least, we expect people who are wrong to feel pretty cheap when they learn from us how wrong they are, and to be eternally grateful to us for explaining things.

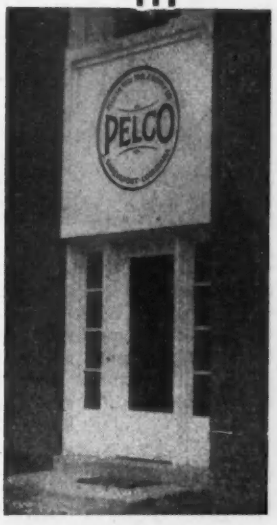
"We Americans have plenty of other and nicer qualities, but this idea that all the world's troubles are caused by failure to listen to us is certainly not one of them. It accounts for too much of the 'Now, you listen to me' kind of talk. . . ."

The fine art of letting other people be wrong is—priceless. It should have a chapter in everybody's How to Win Friends and Influence People.

This fine art stems, not from ignorance or indifference, but from knowledge and interest. It takes into account the fact that the obvious may be nebulous, the proven a fallacy, custom unjustified, opinion groundless. Even mathematical certainties yield to an Einstein.

It takes a big man to let other people be wrong. A sane man. A man who listens more than he talks.

We believe it was Wanamaker who first reached the tactical conclusion that the customer is always right. Call it smart commercial application of a great philosophy. At any rate it made Wanamaker the prince of merchants.



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PELICAN WELL TOOL & SUPPLY CO.

SHREVEPORT LOUISIANA

PELCO

Berwick
New Iberia
Lake Charles

HOUSTON NOMADS INAUGURATE OFFICERS—New officers of the Houston Chapter of Nomads were inaugurated at a dinner-dance attended by more than 400. Front row, left to right: President Homer E. Thornhill, Thornhill-Craver Company; Vice President Furniss M. Prell, Hughes Tool Company; Secretary-Treasurer Jack A. Barnes, Trinity Portland Cement Company. Back row: Assistant Secretary-Treasurer G. R. (Dick) Winder, Well Equipment Manufacturing Company; Sergeant-at-Arms W. H. (Bill) Griffin, Baker Oil Tools, Inc.; Assistant Sergeant-at-Arms Ed. M. Fontaine, National Tank Company; Regent Chas. E. Richards, Gray Tool Company, and Regent C. L. (Luke) Clausel, A-1 Bit & Tool Company.

Gen. Eaker to Address Texas Independent Producers Group

Lt. Gen. Ira C. Eaker, vice president of Hughes Tool Company and pioneer of the Army Air Force, will address the Texas Independent Producers and Royalty Owners Association at its second annual meeting at Corpus Christi, March 11-13.

Luncheon speaker on March 12 will be Steve Stahl, executive vice president of the Oklahoma Public Expenditures Council.

Eaker will address the dinner meeting that night. Business sessions will be held during the morning and afternoon hours of that day, and luncheons for the members and ladies will be held at noon. Standing committees of TIPRO will meet March 11, and informal parties, fishing, golf, and other entertainment will comprise the program March 13.

President H. J. (Jack) Porter, Houston independent, announced appointments to the organization's three standing committees. They are as follows:

Nominations: Walter A. Henshaw, San Antonio; Morris Roberts, Victoria; W. J. Goldston, Houston; Fred Fues, Corpus Christi; Bert Fields, Dallas; C. J. Davidson, Fort Worth; E. A. Ellison, Tyler; H. L. Long, Kilgore; V. C. Perini, Jr., Abilene; Floyd C. Dodson, San Angelo; Reese Cleveland, Midland; C. P. McGaha, Wichita Falls; George B. Cree, Pampa.

Resolutions: P. H. Swearingen, San Antonio; Dennis O'Connor, Victoria; Wilbur L. Ginther, Houston; Maston Nixon, Corpus Christi; J. B. Cowden, Dallas; Gaylord H. Chizum, Fort Worth; Angus Wynne, Longview; Ernest C. Powers, Carthage; P. S. Kendrick, Abilene; Ray B. Johnston, San Angelo; J. E. Warren, Midland; E. C. deMontel, Wichita Falls; C. L. O'Brien, Amarillo.

Budget and finance: L. A. Douglas, San Antonio; T. N. Mauritz, Ganado; Vernon W. Frost, Houston; Tom Graham, Corpus Christi; W. L. Pickens, Dallas; John W. Naylor, Fort Worth; B. G. Byars, Tyler; Joe Mucher, Longview; F. M. Robertson, Abilene; O. W. Greene, San Angelo; J. Gordon Bird, Midland; A. R. Dillard, Wichita Falls; C. J. Oates, Stinnett.

Oil and Gas Reservoirs to be Topic at April Conference

Dr. Donald L. Klatz will be the lecturer at a conference on "Phase Relationships in Oil and Gas Reservoirs" April 7-9 at College Station, Texas, under the auspices of the Department of Petroleum Engineering, Texas A. and M. College.

The program will deal with "General Phase Behavior of Fluids" and "Vapor-Liquid Equilibria," April 7; "Water Hydrocarbon Phase Relations" and "Phase Densities," April 8; "Surface Tension and Viscosity" and "Behavior of Reservoir Fluids," April 9.

Hotel reservations should be made to the LaSalle Hotel or the Charles Hotel in Bryan, Texas, or to the Aggieland Inn, College Station.

Fort Worth Group Elects

R. W. Dudley, the Pure Oil Company, has been elected president of the Fort Worth Geophysical Society. Other officers include P. H. Ledyard, Southern Geophysical Corporation, vice president, and Erick Thomsen, Stanolind Oil Gas Company, secretary-treasurer.

Byrd Expedition Discussed

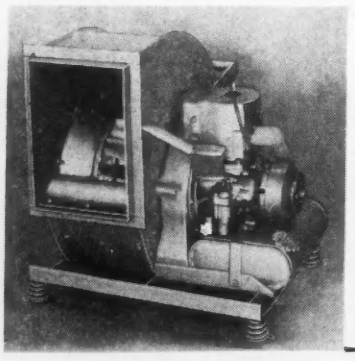
Dr. T. C. Poulter, associate director of the Armour Research Institute, described the Byrd Antarctic Expedition before the Gulf Coast Section, AIME, at Houston February 17.

Geologists Elect

Howard Tipsword, with Magnolia Petroleum Company at Lake Charles, La., has been elected secretary of the Southern Geological Society. He is a graduate of the University of Tulsa.

Vic Indig Elected

Vic Indig, San Francisco export factory representative of the Patterson-Ballagh Division of Byron Jackson, Overstrom & Sons, and Commercial Iron Works, was elected president of the Association of San Francisco Export Managers.



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Men in the Industry NEWS

H. G. Abadie has resigned as California division petroleum engineer for the Union Pacific Railroad Company, Oil Development department, Los Angeles, to assume the duties of senior production engineer for Long Beach Oil Development Company, Long Beach. Prior to his employment with Union Pacific, he was chief petroleum engineer for the Kettleman North Dome Association in the Kettleman North Dome field.

William (Bill) Strickland, formerly assistant manager of the Houston office of Ferguson Well Log Service, has been appointed scout for Skelly Oil Company with offices at Houston. A veteran of more than two years' active service in the U. S. Army, Strickland received his discharge in February, 1946, after little more than a year in the Philippine Islands. He will scout the Gulf Coast area for Skelly.

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End View
Fig. 108 (left) Acme Drilling Bit
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Gage Lund was elected to the board of directors of Standard Oil Company of California. He has been chairman of the board of The California Company and Standard Oil Company of Texas, subsidiaries of Standard of California. Lund joined Standard in 1925 and worked as a geologist and drilling foreman for 11 years until he became division superintendent of The California Company's Gulf Coast Division. In 1938 he was made assistant manager of all operations of The California Company and Standard of Texas, and three years later was elected president of The California Company. He was named chairman of the board of both companies in 1945.

Gage Lund

»

J. H. Hall, manager of the Marketing Engineering department, Shell Oil Company, New York, has assumed the duties of assistant manager of the Operations department in addition to his present assignment. Hall joined Shell in 1932 as an electrical engineer in the head office Marketing Engineering department. In subsequent years he handled assignments as equipment engineer in the head office and as construction and maintenance superintendent in the company's Florida division, and from 1938 to 1946 was chief engineer and later East Line division superintendent of Shell's Products Pipe Line department. In 1946 he became manager of the Marketing Engineering department.

»

H. R. Straight, chairman of the board of directors of Cities Service Oil Company, has announced his retirement after 36 years with the firm. He will retain his post on the board of directors but will leave active business to pursue his hobbies of farming and cattle raising. Straight went to Oklahoma in 1911 to work with the Barnsdall interests and a year later joined Cities Service.

»

Howard Davis has resigned as attorney with Continental Oil Company at Ponca City, Okla., and has moved to Oklahoma City to join the firm of Bulla and Bynum.

»

Mike Hamilton, who recently joined Faultline Oil Company as geologist and petroleum engineer, has resigned to become a consultant at Fort Worth.

»

T. J. Dwyer of Fort Worth has been appointed chief civil engineer for Gulf Oil Corporation at Houston, succeeding **R. L. Woodbury,** retired. **B. W. Miner** has been named assistant chief civil engineer.

Charles L. Harding has been elected a member of the board of director of Socony-Vacuum Oil Company. Harding, formerly a member of the Law department, has been coordinating Middle East interests of the company for the last seven months and will continue to function in this capacity. A graduate of the University of California's School of Jurisprudence, he has been active in the petroleum industry since 1933. During the war he was counsel, and later director-in-charge, for PAW, District 1. At the end of the war he returned to Socony-Vacuum.

C. L. Harding

»

L. R. Caskey, district land man for Continental Oil Company at San Antonio, has resigned to go into business for himself as a broker in oil leases and royalties. He had been with Continental four years and prior to that was for 23 years connected with American Republics Corporation.

»

George W. Levangie has been made petroleum attache at the American embassy at Lima, Peru.

»

Michel T. Halbouty, Houston petroleum engineering consultant, has established a fellowship in geology at Texas A. and M. College. The fellowship will be awarded to a student who has earned part or all his way through college during his undergraduate years, who has graduated from Texas A. and M. and needs financial assistance for further study in the field of geology. It will pay $500 a year to the one selected.

»

William B. Watson is now associated with **David Donoghue,** consulting geologist and engineer of Fort Worth. Watson, formerly in the Production and Engineering departments of Gulf Oil Corporation and captain in the U. S. Marine Corps in the Pacific during World War II, has now completed requirements for the degree of Master of Science in petroleum engineering at the University of Texas.

»

E. M. (Ed) Skeehan, vice president and former treasurer and board member of Barnsdall Oil Company, has retired after more than 40 years with the organization. Skeehan joined the late **T. N. Barnsdall** in 1906 as a personal bookkeeper and continued in that position until Barnsdall's death in 1917. When Barnsdall Oil Company was formed Skeehan became general auditor with headquarters at New York. He moved to Tulsa in 1926 and in 1932 went to California as vice president of the company. In 1940 he returned to Tulsa, where he now resides.

Frank Champion resigned as vice president and general manager of the **Glenn McCarthy** interests to form the Champion Oil and Gas Company. Headquarters will be in Houston with location of the offices to be announced. Champion is a member of the board of directors of Gulf-Canal Lines, Inc., and a director and member of the executive committee of the Second National Bank, Houston. He is a graduate of the University of California and was for 11 years vice president and general manager of Byron Jackson Company before he became associated with McCarthy five years ago.

Frank Champion

»

H. E. Dischinger, for the past year superintendent of Shell Oil Company's "East Products Pipe Line," which runs from Wood River, Ill., to Lima and Columbus, Ohio, has been named general superintendent of the company's products Pipe Line department in charge of operation. He will make his headquarters in New York. Dischinger started with Shell 23 years ago and has served in the manufacturing and marketing departments as well as in transportation and supplies. **J. F. Johnson** succeeds him as acting superintendent of the "East Products Pipe Line."

»

Harold M. Smith has been appointed assistant supervising engineer of the Bureau of Mines Experiment Station at Bartlesville, Okla., succeeding **D. B. Taliaferro,** who has been promoted to engineer in charge of secondary recovery operations.

»

Harold W. Manley, formerly in the gas and natural gasoline department of Barnsdall Oil Company at Tulsa, has been made manager of the Production department.

»

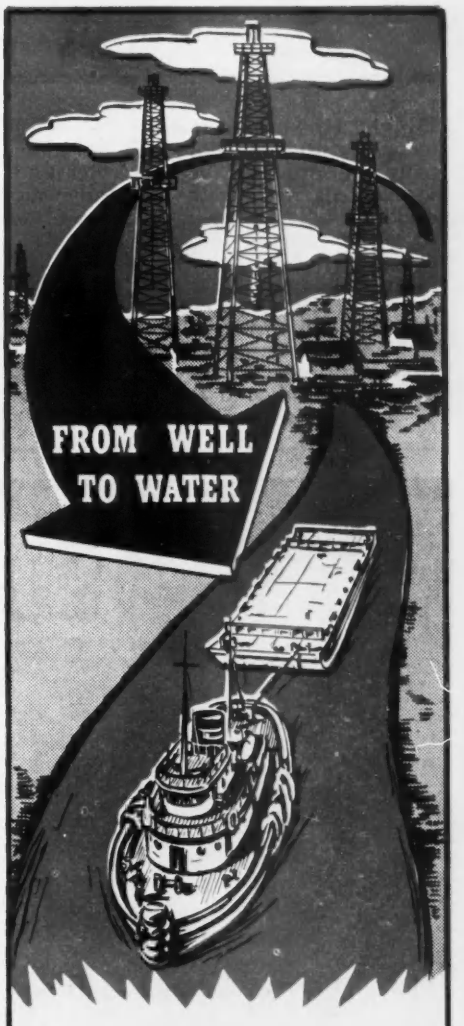
M. L. Kleinsmith, leaser in the Land, Leasing and Scouting department of Gulf Oil Corporation's Houston office, and who has been associated with the firm for more than 20 years, has retired. He will handles leases, royalties, etc., and will continue to reside at Houston.

»

Frank H. Gower, veteran land man for The Texas Company at Denver, has resigned to become an independent operator.

»

George C. McGhee, petroleum geologist now with the State Department, was named by the Dallas Junior Chamber of Commerce as the city's outstanding young man for 1947. He was cited by **Felix R. McKnight,** assistant managing editor of the *Dallas Morning News,* for his service with the State Department, for which he has been director of the Greek and Turkish aid program.



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Dwight H. Fortine, former field petroleum engineer for Barnsdall Oil Company in California, became chief California geologist for the company, succeeding R. T. White, who has resigned to enter business for himself. Fortine, son of **F. A. Fortine,** who was vice president and general superintendent for Barnsdall at the time of his death, has had a varied career in geology and petroleum engineering since his graduation from Stanford University in 1926. After a short period with the State Division of Oil and Gas, he became a petroleum engineer with the Miley Exploration Company. He then went with Caribbean Petroleum Company in Venezuela. After three years he returned to California in 1931, joining Barnsdall, for whom he has been a production engineer and petroleum engineer.

»

E. H. Finch, formerly with the Oil and Gas Division, Department of the Interior, is now associated with Beers & Heroy, Dallas, with headquarters at The Avondale, Washington 6, D. C.

E. Olivari has retired after 39 years with Gulf Oil Corporation and Gulf Refining Company and has been succeeded by **D. F. Sheffield** as assistant auditor. Olivari joined Gulf June 21, 1909, at Beaumont and moved to Houston in 1916 when the Gulf district offices were transferred. Sheffield was born in Houston and has been with the company 25 years. He served in the Navy during World War I.

E. Olivari

»

Albert L. Abercrombie has been named production superintendent for the Musgrove Petroleum Company at Russell, Kansas.

»

Douglas Collier, graduate of the University of Colorado, and **Jerome Wright,** formerly with the Nebraska Geological Survey and U. S. Geological Survey, are now on the geological staff of The California Company, succeeding **R. J. Gill** and **R. L. Kertz,** who resigned to form the Geological Service Co.

Transfers:

Allen Ehlers, geologist for Skelly Oil Company, has been transferred from Tulsa, to Midland, Texas, where he will serve as district geologist for West Texas and New Mexico. **Edward W. George,** title and right-of-way chief for The Carter Oil Company at Mattoon, Ill., to the company's Tulsa headquarters. **Glenn L. Shoemaker,** representative of Stanolind Oil Purchasing Company, from Lubbock to the Midland, Texas, office. **Robert M. Walton,** office manager for Shell Oil Company in Tulsa, has been promoted to assistant manager, Tax department, in the company's headquarters at New York. His successor at Tulsa is **George A. Clark,** transferred from Houston. **Guy Hobgood,** former superintendent at the Concho Indian Agency near El Reno, Okla., to the Jicarilla Apache reservation at Dulce, N. M. **David A. Kinney,** Stanolind Oil & Gas Company foreman at Mannford, Okla., to Denver City, Texas. **W. L. Crothers,** Humble Oil & Refining Company engineer at Midland, to Houston. **A. C. Elliott,** Shell Oil Company geologist at Lake Charles, to Midland, Texas. **William T. Wells,** Gulf Oil Corporation engineer at Philadelphia, to Lansdowne, Penn. **C. D. Mims,** Standard Oil Company of Texas engineer at Houston, to Gainesville, Texas. **E. S. Miles,** Phillips Petroleum Company engineer at Smackover, Ark., to Odessa, Texas. **K. C. Kugler,** Standard Oil Company (Indiana) engineer at Tulsa, to Plainfield, N. J. **L. M. Rhea,** Wheless Drilling Company superintendent at Carthage, Texas, to Junction City, Ark. **Austen M. Shook,** The Texas Company engineer at Freer, Texas, to Alice, Texas.

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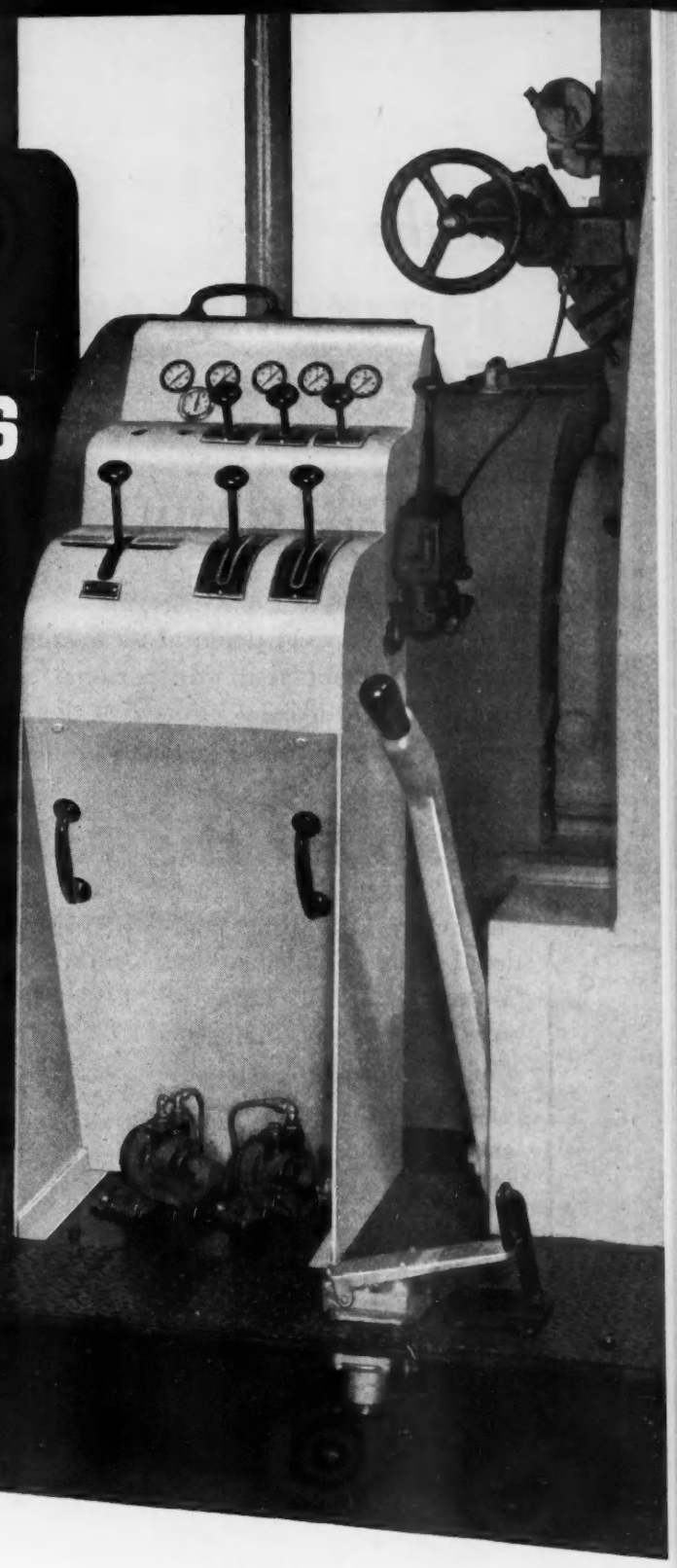

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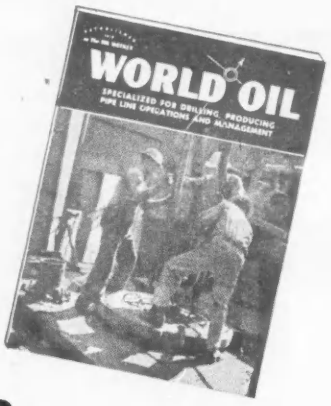

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MEN IN THE INDUSTRY NEWS

G. Stewart Brown, former State Department official, was named manager of the Public Relations department of Standard Oil Company of California. A native of Arizona, he joined the Paris edition staff of the New York *Herald Tribune* after graduating from the University of Arizona in 1927. Two years later he went to the United Press and served until 1939, when he resigned to become director of public information for the American Red Cross in Washington. In 1945 he became director of public relations for the Allied Commission in Italy and later took charge of the United States Information Service in Italy. He held this post until September, 1946, when he returned to Washington and was appointed deputy director of the Office of Information and Educational Exchange, which position he held until he resigned to join Standard.

G. Stewart Brown

»

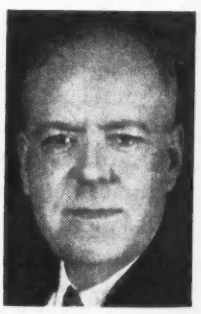
Ed H. Short, who for the past five years has been in charge of *The Oil and Gas Journal's* Gulf Coast engineering office, Houston, has resigned to become associated with the Frank Dyke Advertising Agency, Houston. Prior to his association with *The Oil and Gas Journal,* Short was connected with Gulf Oil Corporation, Tulsa, for 17 years. With this company he served in the capacity of district engineer in several Gulf districts, and as production engineer at Tulsa. Following his engineering assignments he was an executive assistant in Gulf's Tulsa headquarters for a number of years.

»

J. M. Coffield, formerly engineer with the Cotton Valley Operators' Committee, Cotton Valley, La., has joined Sohio Petroleum Company as production engineer in the Shreveport district.

»

Edward H. Chandler, general counsel for the Sinclair companies, has resigned after 35 years of continuous legal service with the organization. Chandler was born at Independence, Kansas, received his law degree from the University of Michigan in 1906, and became associated with the Sinclair interests at Tulsa in 1913. When Sinclair Oil and Refining Corporation was formed in 1916 he was appointed general counsel of Sinclair Oil & Gas Company and other operating subsidiaries. He continued in the same position after Sinclair Oil & Gas Company became Sinclair Prairie Oil Company in 1932. He will be succeeded by **Ralph W. Garrett,** who has been associated with the Sinclair companies since 1916.



Edward H. Chandler

DEATHS

Fred E. Cooper, 60, president of Fred E. Cooper, Inc., Tulsa, was killed February 6 when the two-engine plane he was piloting on a flight to Tampico, Mexico, crashed about 47 miles south of the international airport of Brownsville, Texas. Cooper, who was known as the "flying salesman" to oil men throughout the Mid-Continent area, was on a routine trip to Mexico and Venezuela. He was alone in the plane at the time of the crash. He was a manufacturer and distributor of Allis-Chalmers well servicing equipment. He went to Oklahoma from Kansas as a boy and after engaging in various selling ventures in northern Oklahoma went to Tulsa in 1925. He was one of the founders of the Tulsa Chapter Nomads.

Fred E. Cooper

»

Perry L. Chapman, 59, area superintendent for Stanolind Pipe Line Company, died February 14, at Lubbock, Texas, following a heart attack.

»

Jack A. Lewis, 35, petroleum engineer for Tennessee Gas Transmission Company, Houston, died February 1. A native of Calvert, Texas, he was a graduate of The University of Texas.

»

Richard Airey, 79, former president of Asiatic Petroleum Corporation, died at Billinghurst, Sussex, England, February 2. Airey was born in England and went to the U. S. in 1916. He joined Asiatic Petroleum in 1917 and was president of the firm from that year until 1935, when he retired and returned to England. He was also president of other companies affiliated with Asiatic Petroleum and was a director of several firms, including Shell Union Oil Corporation and Canadian Eagle Oil Company, Ltd.

»

B. F. Bart, 60, Southwestern district executive administrator for the A. O. Smith Corporation, died February 12 at Houston. A native of Wilkes-Barre, Penn., Bart went to Houston in May, 1942, as executive administrator for the government-built A. O. Smith Corporation-operated war plant. He had been general sales manager for the company in Dallas for a number of years before moving to Houston.

»

Clyde G. Morrill, 58, Wellesley, Mass., executive secretary of the Independent Oil Man's Association of New England, and an industry consultant for state and national governments, died February 5. Morrill was a member of the NPIC under Harold Ickes during the war and also was a member of the OPA Industry Advisory Committee. He recently was named New England representative on the National Petroleum Council.

»

John W. Pevey, 66, retired independent oil operator, died February 7 at Dallas.

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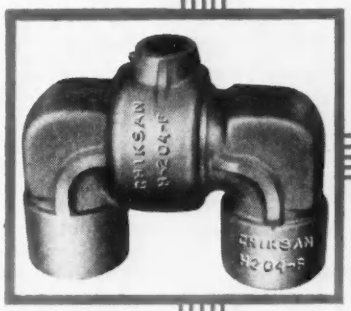
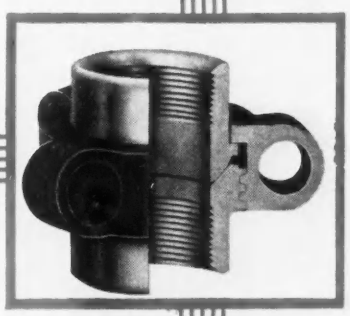


CHIKSAN Ball-Bearing SWIVEL JOINTS



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EQUIPMENT AND SERVICE SUPPLIERS' NOTES

Walter W. Trout Named President Of Lufkin Foundry and Machine

Walter W. Trout was elected president of Lufkin Foundry and Machine Company. Trout, who has been with the company 23 years, beginning as a machinist in 1925, succeeds his father, the late W. C. Trout, who had headed the foundry since its start early in the century. Walter Trout has been vice president and general manager of the foundry, and since the death of his father in April, 1947, has been acting head of the industry.

Walter W. Trout

Trout is a graduate of Purdue University and attended Rice Institute and The University of Texas.

W. D. Winston, Jr., who has been with the company 34 years, was elected to the board of directors to fill the vacancy left by the death of W. C. Trout. All other officers and directors were reelected.

Vice presidents are J. H. Kurth, Jr., Houston; E. P. Trout, Lufkin; A. E. Cudlipp, Lufkin; and L. A. Little, Dallas. Winston was reelected secretary and E. H. Bounds was renamed treasurer.

The board of directors includes Walter Trout, J. H. Kurth, Jr., E. L. Kurth, Little, S. W. Henderson, Jr., Eli Wiener of Dallas, Cudlipp, Jacques Wiener of Shreveport, and Winston.

Goodyear Appointments Made

Louis W. Rasor has been appointed district sales manager of Goodyear Tire & Rubber Company's Mechanical Goods Division, at Charlotte, N. C., it was announced by H. D. Foster, manager of the Mechanical Goods Division. The district embraces North and South Carolina and parts of Virginia and West Virginia. Rasor succeeds Richard G. Abbott, who becomes district manager at Los Angeles. Abbott has held the Charlotte post since the district was established in 1945.

Addition Made to Sales Staff Of Nordstrom's Houston Office

R. J. Munn has joined the sales staff of Nordstrom Valve Division, Rockwell Manufacturing Company, and has been assigned to the Houston office to work under the direction of C. K. Madison, district manager.

R. J. Munn

Munn was formerly an Army pilot and spent three years as a commissioned officer in the Air Corps. Prior to the war he studied engineering at Texas A. and M. College. He has had recent experience in the oil fields where he worked in various capacities on drilling rigs. He will make his home in Corpus Christi, Texas.

The Igloo WATER COOLER
"the truly Convertible Cooler"

This cooler is corrugated for greater strength and durability being of all welded construction. It is fully insulated with granulated cork to keep water colder longer. Added features include, conversion from spigot to non-spigot type, no solder joints to break out and a reinforced innerbottom.

Igloo Water Coolers and Spigots Are Available at All Supply Stores

The IGLOO MANUFACTURING CO.
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The first of a series of five volumes dealing with the application of the basic engineering principles of drilling oil wells and extracting the oil most efficiently and economically. Presented by a nationally known authority, formerly with The Texas Company, the information is highly practical, and is detailed, specific, and thoroughly documented. The treatment is as clear, concise, and simple as possible, and the explanatory matter is illustrated by extensive use of graphs.

This volume and those in preparation should be welcomed by all petroleum technologists, geophysicists, mechanical engineers and physical chemists as an outstanding contribution which fills a vacuum in the literature of petroleum. It assembles a vast amount of data which were previously scattered or unsystematized and provides a quick and accurate reference source for the entire industry.

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This is the second in a series of five volumes which will comprise the most thoroughgoing treatment of the engineering aspects of petroleum production ever presented. Contents include: The Maximum Efficient Rate of Production; Oil, Condensate and Natural Gas Reserves; Well Producing Capacity for Reservoirs; Interest Factors; The Period of Development; Uniform Rates of Production; Uniform Rates of Depletion; Economic Limits for Wells and Reservoirs; Increasing Rates of Depletion; Decreasing Rates of Depletion; The Optima for Uniform Rates of Depletion; The Optima for Variable Rates of Depletion; Exponential Functions; Natural Logarithms. 295 Pages, $4.50

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Third volume deals with the application of the basic engineering principles of drilling oil wells and extracting the oil most efficiently and economically.

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Simplified controls mean ease of operation. That's why UNIT RIG controls are designed for finger-tip operation, and the number of controls reduced to the minimum. All controls are grouped together within easy reach of the driller. UNIT RIG's simplified controls reduce fatigue of the operator, lessen the possibility of error, and save time during drilling operations. This simplified control design is another UNIT RIG *exclusive.*

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TULSA, OKLAHOMA U.S.A.

DESIGNED FOR THE JOB . . .

Exclusive Export Representative
MID-CONTINENT SUPPLY CO.
42 Broadway, New York City
Cable Address: MIDUNITRIG

Oil Well Supply Names Manager for New Store at Bartlesville

Opening of an Oil Well Supply Company sales office at Bartlesville, Okla., with Charles A. Baker in charge, was announced by M. Barkhurst, Mid-Continent division manager for this U. S. Steel subsidiary.

Baker has been manager of the Beaumont, Texas, store since September, 1938.

A native of Lambert, Okla., Baker joined "Oilwell" in 1928 and served at Tonkawa, Okla., Blackwell, Okla., Winfield, Kansas, and Eldorado, Kansas, before going to Beaumont as assistant manager in 1935. He held that position until his appointment as manager in 1938.

Dallas District Sales Engineer Named by Link-Belt Company

John Yetter has been appointed district sales engineer for Link-Belt Company with headquarters at Dallas.

A graduate of Texas A. and M. and an air force veteran, Yetter joined Link-Belt two years ago. He will specialize in the application of ball and roller bearings to oil field operating equipment.

E. O. Layman

O. W. Flanders

Promotions of Three Technical Men Announced by Kobe, Inc.

Promotions of three key technical men was announced by Kobe, Inc.

John J. Prichard

O. W. Flanders, California technical service manager, has been promoted to chief field engineer. He will head the company's field technical work in the General Technical Service division under W. F. Slater. One of Kobe Inc's., oldest technical men, Flanders installed the first hydraulic oil well pump in 1932 in a Baldwin Hills, California, well.

E. O. Layman, chief field engineer for the Mid-Continent Technical Service section, has been transferred to the West Coast as manager of California technical service. Layman has been a member of the Kobe organization since 1937. All but a year of that time has been spent in the Mid-Continent.

John J. Prichard, who since 1943 has been manager of the Kobe West Texas and Oklahoma districts, has been promoted to division field engineer of the Mid-Continent Technical Service section. He is an experienced driller as well as production man. He joined the Kobe organization in September, 1940, at Oklahoma City.

Personnel Changes Announced By Continental Supply Firm

The Continental Supply Company, Dallas, has announced personnel changes.

Lawrence E. Young has been appointed store manager at Russell, Kansas, succeeding Roy B. Ball, who has been made a sales representative at the same point. Young was formerly floor man at Russell.

William G. Sharp, former salesman at Houma, La., has been appointed store manager at the same location. He succeeds D. L. Cenac, who has been transferred to Continental's Houston store.

R. W. Griffin, former store manager at Casper, Wyo., has been moved to the Laurel, Miss., store in the same capacity. He succeeds T. F. Morton, who has been transferred to Casper as manager.

Bottom Water is a costly profit leak

Eagle Lead Wool

***stops* Bottom Water!**

You rule out the risk of oil-wasting bottom water shutdowns when you tamp Eagle Lead Wool in the hole. This finely stranded, non-corrosive metallic wool makes a water-tight plug that seals every crack and crevice. Comes in convenient 50-pound sacks—easy to place in special cartridge-shaped Eagle Wire Containers sized to fit all casings. Order through your jobber today.

These 3 Eagle Bearing Metals meet most requirements

Eagle Dreadnaught—for extreme speed and heavy-duty conditions.

Eagle Outlasta—for medium speed and average-load conditions.

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EAGLE LEAD WOOL

Seals off Bottom Water—keeps 'em flowing!

THE EAGLE-PICHER COMPANY

EAGLE Since EP 1843 PICHER

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Built for Heavier Power Transmission

Manhattan's method of pre-stretching the Strength Members of Condor V-Belts insures dependable and *uniform* power delivery of every belt in the set.

Strength Members are so thoroughly impregnated and covered with Flexlastics that atmospheric conditions cannot affect belt length. Thus you don't lose power through stretching and slippage, nor do you lose belt life through shrinkage and excessive tension.

Manhattan's big teams of Condor V-Belts are built to keep pace with today's heavier demands of bigger pumps and higher rig floors. Plenty of cushion keeps them running cool internally. Rugged side walls grip the grooves with positive pressure. Covers are heavy duty and practically weather-proof.

Manhattan V-Belts also can be made in Oil-Proof and Non-Spark constructions.

Whatever your requirements, your rigs will run smoother if you equip every part with Manhattan—Rotary Hose, API Flat Transmission Belts, Condor V-Belts, etc. Try Manhattan and compare for quality. ("Flexlastics" is exclusive with Manhattan)

RAYBESTOS R M MANHATTAN

RAYBESTOS-MANHATTAN INC.

Keep Ahead with Manhattan

MANHATTAN RUBBER DIVISION **PASSAIC, NEW JERSEY**

Core Lab Puts Largest Portable Field Laboratory Into Service

W. H. Davison

W. H. Davison, president of Core Laboratories, Inc., Dallas, announced that final inspection and testing has been completed on the company's newest portable core analysis field laboratory, believed to the the largest of its type in the world. Core Lab's fleet of active portable units now totals 22, in addition to seven stationary laboratories at Dallas, Houston, Corpus Christi, Shreveport, Oklahoma City, Evansville, and Bakersfield.

Initial operation of the new laboratory, specifically designed and equipped to simultaneously analyze 60-foot cores indigenous to drilling in the Rocky Mountain area, will be from a semi-permanent location in the Rangely field, Colorado.

Planned, engineered, and constructed under the direction of John D. Wisenbaker, manager of operations, at a cost of approximately $10,000, the all-aluminum trailer-type lab measures over 28 feet in length and weighs 6000 pounds. Cabinets, doors, and other fixtures are also of aluminum, making the entire unit completely corrosion and rust-proof.

Arrival of the lab from Dallas will be of special interest to Colorado operators who have been employing the diamond-head type core barrel in virtually all coring programs. Each run of the latter usually results in the taking of up to 60 feet of subsurface samples from formations heretofore extremely difficult to do. Nine engineers, under the supervision of James D. Harris, district engineer, will offer continuous 24-hour service in the large laboratory.

Davison has been president of the firm since September, 1947. He joined Core Laboratories in January, 1946, as sales manager, and became vice president in January, 1947. He previously served with Magnolia Petroleum Company, Dowell Incorporated, and Case and Company.

TRAVELING LABORATORY—John D. Wisenbaker, manager of operations, inspects the largest portable core analysis field laboratory in the world, specifically designed and equipped by Core Laboratories, Inc., Dallas.

$600,000 Improvement Program Started By Cooper-Bessemer

The Cooper-Bessemer Corporation, manfacturers of diesels, gas engines and compressors, has begun a $600,000 improvement program in an effort to increase its production of equipment sorely needed to help alleviate the shortage of natural gas.

Authorization for the program was granted by the company's board of directors, B. B. Williams, chairman of the board, announced.

The program calls for the purchase of $325,000 worth of new machine tools for its Grove City, Penn., plant and the expansion of its foundry facilities, and about $275,000 for equipment for the Mount Vernon plant, Williams said.

The machinery, which is largely to replace present equipment, consists of large facing tools and boring and drilling equipment. Officials estimate that production will be increased by from 25 to 30 percent as a result of these expenditures.

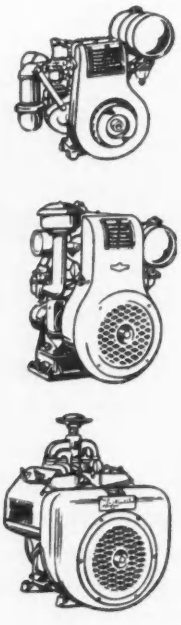
Cooper-Bessemer is currently producing several sizes and types of compressors for use on natural gas pipe lines and in plants which process gas for the extraction of gasoline and fuel oil. Included among these compressor types is the new GMW, largest of its kind in the world.

The REAL MEASURE of ENGINE VALUE is "H. P. HOURS" of POWER SERVICE

It isn't the original H.P. rating of an engine that counts but rather, the number of H.P. Hours of power service it will deliver during its lifetime. This, in the final analysis, is the real measure of engine value.

Wisconsin Air-Cooled Engines deliver the most H.P. Hours because they are designed and built for rugged, heavy-duty service. For example: every Wisconsin Engine, from the smallest to the largest, runs on Timken tapered roller bearings at both ends of the crankshaft to take up end-thrust and provide the best protection against bearing failure . . . at the same time assuring a smooth-running engine. This is just one typical detail that stands back of "Most H.P. Hours" of on-the-job power service.

You can't go wrong if you specify "Wisconsin Air-Cooled Engines" to meet your power requirements, within a 2 to 30 hp. power range.



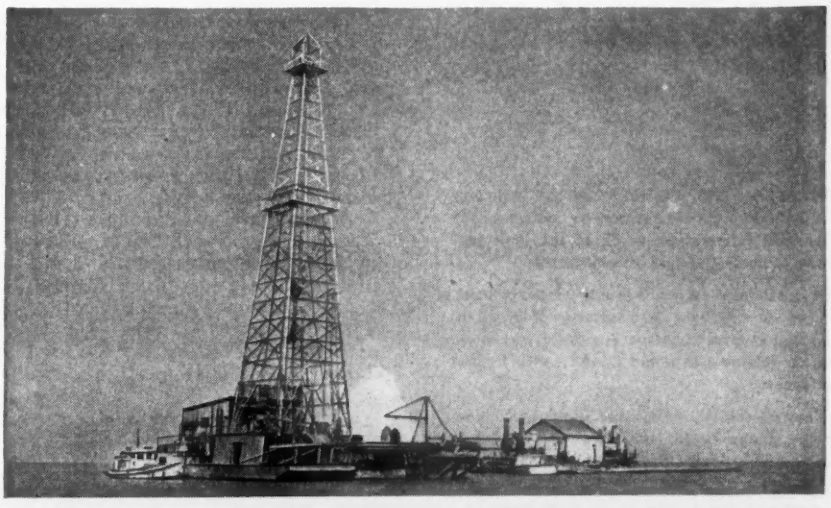
Wisconsin Engines are available in a complete range of types and sizes (all 4-cycle) from 2 to 30 hp.

WISCONSIN MOTOR Corporation
MILWAUKEE 14, WISCONSIN
World's Largest Builders of Heavy-Duty Air-Cooled Engines

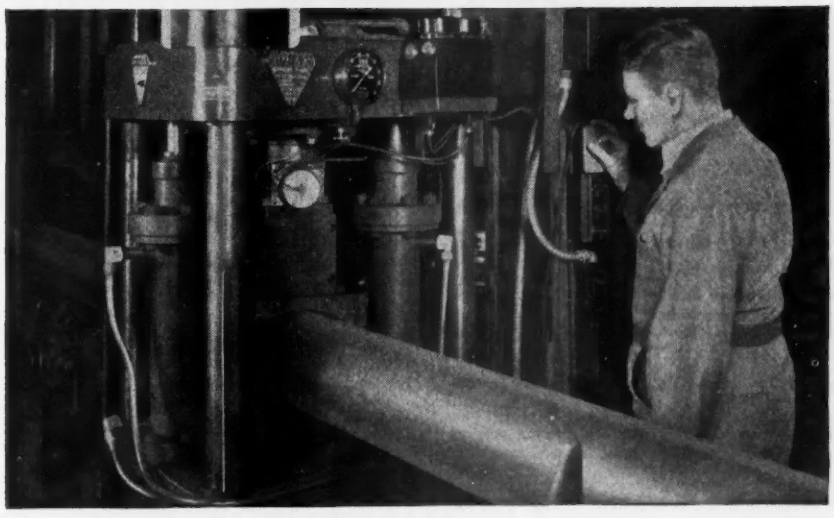
WRITE TO HARLEY SALES CO.
510 Atlas Building, Tulsa, Oklahoma
M & M Building, Houston, Texas
Oil field distributors for Wisconsin Engines and all types of utility units.

DEPENDABILITY

THROUGH RESEARCH



TWO MILES OFFSHORE: 2900 feet of 45.5-lb. round-thread, high-yield SMITHway Casing —in Galveston Bay, Texas.



IN THE A. O. SMITH MILL: Every length of SMITHway Casing goes through this hardness-testing machine which automatically registers hardness uniformity.

SMITH*way* CASING · LINE PIPE

A. O. SMITH CORPORATION

New York 17 • Pittsburgh 19 • Atlanta 3 • Chicago 4 • Tulsa 3 • Dallas 1
Houston 2 • Seattle 1 • Los Angeles 14 • International Division: Milwaukee 1

Three Factory Branch Managers Appointed by General Controls

Appointments of three factory branch managers for General Controls Company were announced by J. F. Ray, director of sales.

Don S. Bentley, who has been a factory sales supervisor with the company for several years, has been named factory branch manager at Los Angeles. F. E. Weldon, the company's former AGA representative at Cleveland, has been named factory branch manager at New York. C. G. McCarthy, who has had extensive experience in the electrical, mechanical and control industry, has been named Detroit factory branch manager.

Manager of Panhandle District Appointed by Bethlehem Supply

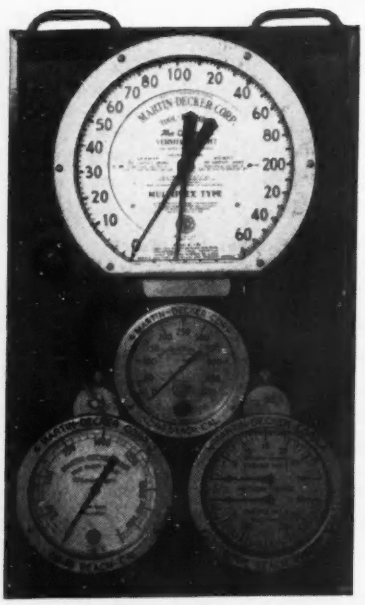
Bethlehem Supply Company has promoted H. S. Sutton to manager of the Panhandle District with headquarters at Pampa, Texas.

Sutton has been employed by the Bethlehem Supply Company for the past four and one-half years and has been located in the Kansas District during his entire service with the company.

Combines all the advantages of "Sealtite" Construction

RUGGEDNESS — ACCURACY — SENSITIVITY

THE "Sealtite Clipper"



THE "SEALTITE" CLIPPER Weight Indicator and Drilling Control Instrument provides the driller with information on all of the important drilling factors—not just weight alone.

An instrument which reliably shows weight, mud pressure, torque and rotary table speed, assembled in a small compact case for jack-knife derricks, folding masts and derricks with limited floor space.

It has all the flexibility of a Toolpusher Model but the gauge is not subjected to the violent whip and vibration of the dead line.

You can install or move a "Sealtite" Clipper just as quickly and easily as a Toolpusher type and it will last much longer.

Made in a wide variety of combinations . . . there is a "Sealtite" Clipper available for very purpose.

IT'S TOUGH The "Sealtite" Clipper is built for rough and ready work and can take it.

IT'S SENSITIVE Controlled hydraulic operation with a 6 to 1 ratio super sensitive vernier indicates the slightest change in weight on bit or pull on derrick.

IT'S COMPACT AND COMPLETE Weight Indicator and Vernier Indicator, Mud Pressure Indicator, Steam Torque Indicator and Rotary Table Tachometer are mounted and protected in a compact, strong 16" x 16" x 26" steel box. All indicating gauges are available with recorder except the Rotary Table Tachometer.

IT'S MODERN Immediately adaptable to any type of rig, large or small. The latest thing for use with mast, jackknife, folding derricks or any rig with limited floor space.

IT'S MOVABLE Just remove weight diaphragm from dead line, unscrew Mud Diaphragm, coil up both hi-pressure hoses, place diaphragms and hose in box, shut doors and load in car—that's all there is to it.

IT'S SEALED Vacuum loaded at the factory and permanently sealed. No adjusting—no pumping up. The gauge can be set wherever desired for greatest convenience.

The "Sealtite" Clipper is immediately adaptable to any type of rig, large or small.

HOME OF THE WEIGHT INDICATOR

MARTIN DECKER CORP.

LONG BEACH, CALIFORNIA

SAN JOAQUIN VALLEY T. J. CULLEN BAKERSFIELD, CALIFORNIA

MID CONTINENT DISTRIBUTOR REED ROLLER BIT COMPANY HOUSTON, TEXAS

E. E. Smith

J. R. Boax

E. E. Smith, J. R. Boax Given Promotions by National Tube

Appointment of E. E. Smith as manager of sales of National Tube Company for the Southwestern area, with offices at Dallas, was announced by H. J. Wallace, general manager of sales of this U. S. Steel subsidiary.

The announcement was made at a district sales conference attended by managers of National Tube Company divisions of Dallas, Denver, Houston, New Orleans, and Tulsa. Smith will have general supervision over these five divisions.

Also announced was the appointment of James R. Boax as manager of sales at Houston, succeeding Smith.

A graduate of Carnegie Institute of Technology, Smith spent several years in the engineering and operating departments of the company's National Works at McKeesport, Penn., before going to Texas as a field engineer in 1929. He served as director of service for National Tube's sales department, was made manager of sales at Tulsa in 1943, and went to Houston in the same capacity last year.

Boax is a graduate of Syracuse University and has had 17 years' experience with National Tube and Oil Well Supply Company, also a U. S. Steel subsidiary. After four years with the operating department at National Works, he became a field service engineer in 1934. Subsequently he was a salesman for National Tube in Tulsa, district manager of tubular sales for Oil Well Supply, assistant priorities administrator of National Tube during the war, and recently a salesman in the Houston office.

Promotions Received by Three Executives of Wheatley Firm

The executives of Wheatley Pump and Valve Manufacturers have received promotions.

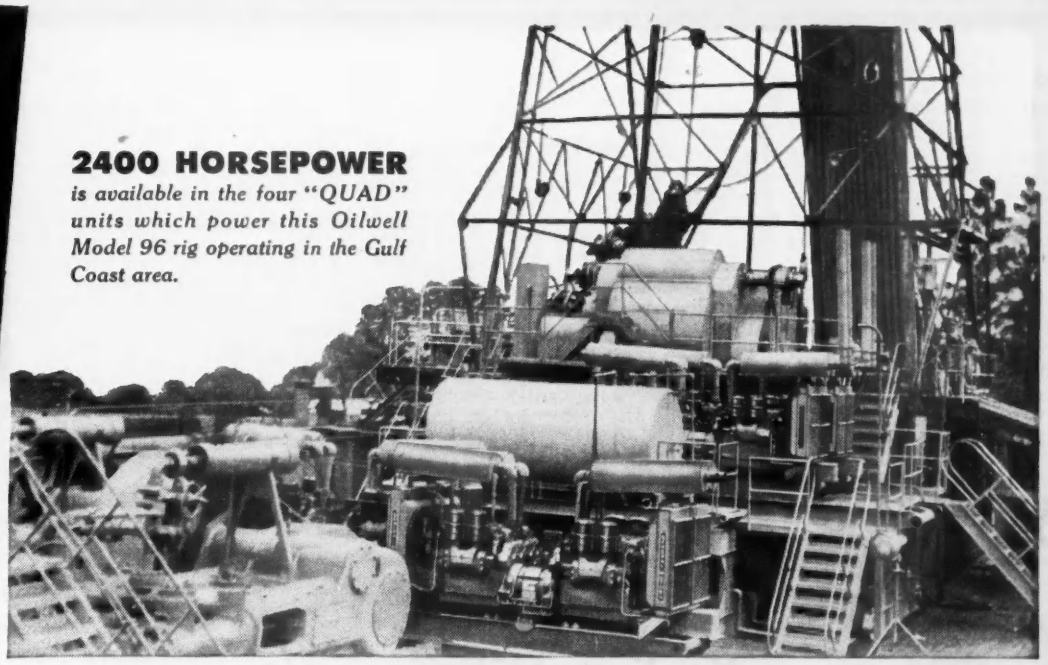
Frank Wheatley, Jr., was named executive vice president; Frank Wheatley, Sr., was reelected president; Gus Baker, Jr., was named vice president and general manager; and William J. Gray, veteran of 30 years with the firm, was elevated to vice president in charge of manufacturing.

Miss Dorothy Page, secretary-treasurer, is retiring after more than 20 years with the company. She began with Wheatley Pump when it began operations in Tulsa. She will be succeeded by Dan L. Lingo.

Earl Wagner, who has spent more than 30 years with the company, is retiring from his position as shop superintendent. His position will be filled by Grady Maguire.

LESS SPACE

2400 HORSEPOWER
is available in the four "QUAD" units which power this Oilwell Model 96 rig operating in the Gulf Coast area.



General Motors "QUAD" provides 600 H. P., weighs 12,500 lbs.

Take a good look at this powerful unit. It delivers a maximum of 600 horsepower or 520 rugged, continuous horsepower at 900 R.P.M. of the shaft. Any of its four engines can be shut down when not needed.

The GM "QUAD" consists of four GM Series 71 Diesels mounted compactly in a single unit and geared to a single output shaft. This makes big horsepower available with very much simpler compounding and with fewer units.

In themselves, GM Diesels are compact and low in weight for their horsepower. Matched snugly in the "QUAD" and mounted on skids, they become a powerful unit that takes a minimum of space and is free of excess weight. This means it is far easier to move them from job to job.

These are some of the reasons you see more and more GM Diesels—singles, "Twins" or "Quads"—powering rigs in all of the oil fields. We'd like to give you all the features. Just drop us a line.

DETROIT DIESEL ENGINE DIVISION

SINGLE ENGINES.. *Up to 200 H.P.* **DETROIT 28, MICHIGAN** MULTIPLE UNITS.. *Up to 800 H.P.*

GENERAL MOTORS

Diesel Brawn without the Bulk

GM
GENERAL MOTORS
DIESEL POWER

United Supply's Houston Store Manager Goes to Oklahoma City

James F. Garth, Jr., formerly manager of United Supply and Manufacturing Company's Houston store, has been transferred to the Oklahoma City store as manager. He is succeeded by H. M. Booker, formerly with Houston Oil Field Material Company.

Sand-Banum Named Distributor

Western Sand-Banum Company, 703 M & M Building, Houston, has been appointed distributor for Masters anti-acid lubricants made for packing glands in corrosive service, and Masters metallic compound used to protect threads in all types industrial service.

Two Vice Presidents Elected To Chain Belt Company Board

L. B. McKnight and O. W. Carpenter were elected directors of Chain Belt Company at the annual stockholders meeting.

McKnight was recently elected a vice president of Chain Belt Company with executive responsibility for the two heavy machinery divisions. Carpenter was recently elected a vice president of the company in charge of finance.

Type 75-RP King Swivel

Patent Pending

Be Sure IT'S A KING Be Safe

For Drilling Medium Depth Oil Wells
For Deep Slim Hole Drilling
For the Heavier Work-Over Rigs
For Drilling Deep Water Wells

This is a new type swivel and is heavier than other King Swivels. It is recommended for drilling oil Wells to a depth of 6,000 feet with 4½" drill pipe.

This swivel has no washpipe or stuffing box. A moulded rubber packing provides a very effective seal and is automatic in its sealing action.

Adjustment of the packing is simple and it can be renewed in a very few minutes through openings in the lower section of the housing.

Alloy steel is used throughout in the manufacture of this swivel except some minor parts are of manganese bronze.

Like all King Swivels, this one has extremely high capacity in ratio to its weight.

See Pages 2130 and 2131 of the 1948 Composite Catalog for more details on this swivel.

Please order through your supply store.

Export: **R. S. STOKVIS & SONS, INC.**
17 Battery Place
NEW YORK 4, N. Y.

See pages 2129 to 2140, Volume 1, 1948 Composite Catalog for other King Oil Tools.

KING OIL TOOLS
210 TERMINAL STREET PHONE W. 6-8013
HOUSTON 10, TEXAS

A. B. Hamil Elected President of Marine Exploration Company

A. B. Hamil was elected president at the first stockholders' meeting of Marine Exploration Company, Houston.

A. B. Hamil

Other officers are Gordon M. Mace, Jr., vice president in charge of interpretative analysis; R. W. Upshaw, vice president in charge of field operations; Mrs. Ferne Hamil, secretary - treasurer; and Miss Bette Muir, assistant secretary-treasurer.

Charles R. Hrdlicka was appointed attorney for the corporation, and B. Hunter Loftin was named tax consultant. Both are members of the firm of Butler, Binion, Rice and Cook.

Marine Exploration was organized to perform specialized marine seismic surveys with specially designed and constructed compact waterproof seismic instruments and auxiliary surveying and drilling equipment in the swamp, marsh, and water regions of the Gulf Coast area and foreign areas of inaccessibility. The company has also provided special equipment for the rugged terrain of the Rocky Mountain district. The company operates as a contracting and consulting geophysical service for numerous oil companies.

MacClatchie Complete Quarter Century of Service to Industry

The end of 1947 rounded out a quarter century of service to the oil industry by MacClatchie Manufacturing Company, Compton, Calif. The growth of this firm from its start in 1922, in a one-car garage structure in Brea, Calif., to its present complete plant in Compton is a story of pioneering and growth which parallels the rise of the petroleum industry.

The MacClatchie firm was first to introduce many features of mud pump valves and pistons, including the hardened and ground valve seat, the cup-type replaceable piston rubbers, and similar improvements.

The firm is still headed by its founder, J. Warren MacClatchie, who initiated the original business to manufacture oil field specialty items. In 1923 MacClatchie realized that the fast-growing petroleum industry would require increased specialty tool facilities, and he moved the plant to Compton.

In the past 25 years, MacClatchie has built the firm up to its present position as one of the leaders in the business, selling oil tool equipment throughout the world.

Garrett Moves Offices

Garrett Exploration Company has moved its offices from 7015 Hillcrest, Dallas, to its new plant and office building at 5531 Yale Boulevard.

SHOCK ABSORBER...

FOR MAN... AND MACHINE

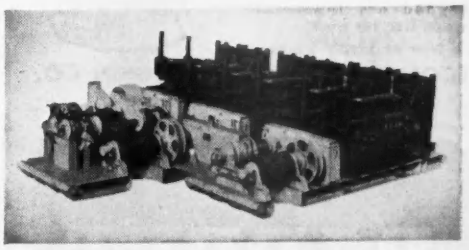
Pneumatic-tube Clutch Provides "Life Insurance" for Your Machines

Shock? Vibration? Not in modern drilling rigs equipped with Fawick Airflex Clutches!

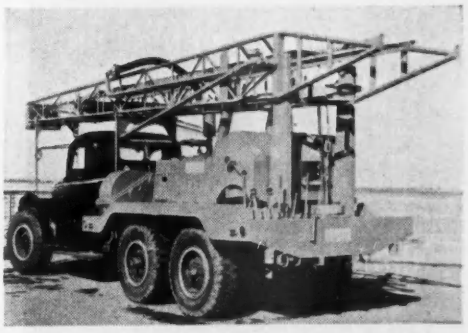
The Fawick Clutch transmits power through friction shoes carried on a rubber-and-cord tube actuated by air pressure. This flexible air cushion acts, literally, as a shock absorber and vibration cushion . . . protects the entire machine against needless wear and tear, prevents operator fatigue, gives perfect clutch control, perfect shock absorption.

Job-proved, Fawick Clutches meet the toughest operating conditions on mud pumps, engine and rotary table drives and hoist drums.

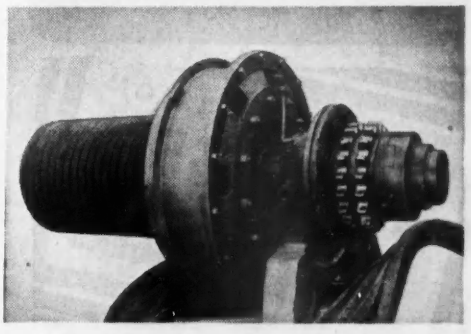
Avoid unnecessary parts replacement costs, needless down-time—always specify Fawick for your equipment.



Mid-Continent Supply Company's 6-engine Compounding Drive equipped with 14 Fawick Clutches.



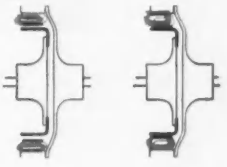
Franks Machine Company Portable Rig with Fawick Transmission Clutch and Drum Brake.



Wilson Titan Rig with Fawick Conversion Pump Drive Clutch.

HERE'S HOW IT WORKS

Compressed air expands the rubber-and-fabric tube to engage clutch with any degree of "grip" you want. Release the air and clutch disengages.



FAWICK *Airflex* and AIRING **CLUTCH**

Mid-Continent Supply Co., Ft. Worth, Texas

U. S. Oil Field Distributors and Service

FAWICK AIRFLEX CO., INC. 9919 Clinton Rd., Cleveland 11, O.

In Canada, Renold-Coventry Ltd., Montreal, Toronto, Vancouver, Quebec • *In Britain,* Crofts Engineers, Ltd., Bradford, England

ECOLITE-92BM

With Locking Device and Seals

TWICE APPROVED for DOUBLE SAFETY

Approved by U. S. Bureau of Mines and Underwriters' Laboratories

—for use in atmospheres containing Methane or natural gas, gasoline or petroleum vapors.

This double-safety lantern has a tamper-proof reflector and cover with locking device and seals. Throws 1500 foot beam. Instantly ejects broken bulbs from battery circuit. Large handle. 360° pivoting feature gives direct illumination where needed and leaves both hands free for work.

Now at Supply Stores

ECONOMY ELECTRIC LANTERN CO.

Sturgeon Bay, Wisconsin

BARRET

SPECIALIZING IN MAGNETIC SURVEYS

Contracts accepted for domestic and foreign projects, using the most improved instrumental and interpretative technique.

William M. Barret, Inc.

Consulting Geophysicists

GIDDENS-LANE BUILDING
SHREVEPORT, LOUISIANA

QUICK REPAIRS ON **CONDENSERS** and **HEAT EXCHANGERS**

If you need condenser or heat exchanger repairs in a *hurry* call us. We specialize in fast, high quality work.

25 Years Successful Experience

GULF ENGINEERING CO., INC.

Service Not Promises

1682 INGEBORG ST. HOUSTON, TEXAS

916 S. PETERS STREET NEW ORLEANS, LA.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

SALESMEN AT MISSION MEETING—Salesmen from throughout the U. S. were in Houston for Mission Manufacturing Company's annual sales meeting. Spokesmen for this oil well equipment manufacturer said the 1948 gathering was the most successful in the company's history. The sales force studied methods of improving service, learned about new Mission products, and discussed mutual sales problems. Present, and shown above, were (left to right), front row: Melvin C. Davis, Denver; A. R. (Blondy) Parker, Kansas; Cecil Cardinal, Craig, Colo.; L. L. (Bud) Roberson, Bakersfield, Calif.; W. C. Underwood, domestic sales manager; F. S. (Shad) Mims, city sales representative; Joe E. Young, Oklahoma; J. E. (Chubby) Nolen, Jr., Lafayette, La.; Chas. W. Fryar, Wichita Falls, Texas; O. K. Ryan, Lubbock, Texas; W. T. Campbell; Dan J. Ollre, Houston; Jack H. Bannister, Old Ocean, Texas; and Jeff Tucker, factory representative, New York. Back row: Cobb L. Turner, Shreveport; Lonnie M. Roberson, Long Beach, Calif.; John H. Bannister, Old Ocean; A. E. (Higg) Higginbotham, Brookhaven, Miss; Robert L. Creasy, sales office administrator; S. L. Heidemann, chief clerk; T. W. Adair, Jr., field serviceman and pilot; E. H. (Gene) Trammell, export sales manager; C. O. (Calvin) Bell, Jr., Mt. Vernon, Ill.; W. F. Bennett, Odessa, Texas; and R. W. (Rob) Chapman, Corpus Christi, Texas. Members of the sales division not shown in the picture are Tony Volotko and Joe Scalise, field servicemen.

C. P. Collins Named President of Norma-Hoffman Corporation

Charles Pomeroy Collins has been elected president and a director of The Norma-Hoffman Bearings Corporation, Stamford, Conn.

C. P. Collins

Collins was formerly secretary and general counsel of SKF Industries, with which he was associated since 1942. Born at Cleveland, he attended the University School, Cleveland; Mercersburg Academy, Mercersburg, Penn.; Princeton University, Columbia University Law School and received his LLB from New York University in 1928.

Stock in Halliburton Canadian Firm Acquired by Duncan Concern

Stock in the Halliburton Oil Well Cementing Company, Ltd., of Calgary, Alberta, has been acquired by Halliburton Oil Well Cementing Company, Duncan, Okla. The Canadian organization will hereafter be operated as a subsidiary of the Oklahoma company, according to John C. Halliburton, president of the parent company.

Officers of the new company will be R. H. Gibbons, president, John C. Halliburton, vice president, and N. D. McDermid, secretary.

No changes in personnel will be made and the Canadian firm will continue to operate under its title, Halliburton Oil Well Cementing Company, Ltd. Gibbons will direct all Canadian operations as he has in the past.

Erle P. Halliburton, Los Angeles, founder of both companies, was sole owner of Howco, Ltd., before its consolidation into the Oklahoma organization.

In addition to services yearly to the oil industry in 35 or 40 states in the U. S., Howco also maintains foreign service branches or representatives in Canada, Venezuela, Peru, Colombia, Kuwait, Saudi Arabia, Borneo, Dutch East Indies, and London, England.

KLEEN-A-WELL

for Oil and Gas Wells

★ QUICK ★ INEXPENSIVE

New non-explosive, non-inflammable solvent, KLEEN-A-WELL removes paraffin and asphaltum from oil wells, gypsum and salt from gas wells. 1 shot (60 lbs. in 6-gal. container) usually sufficient to treat average depth well, depending on condition.

Write or Wire

THE SULLIVAN COMPANY

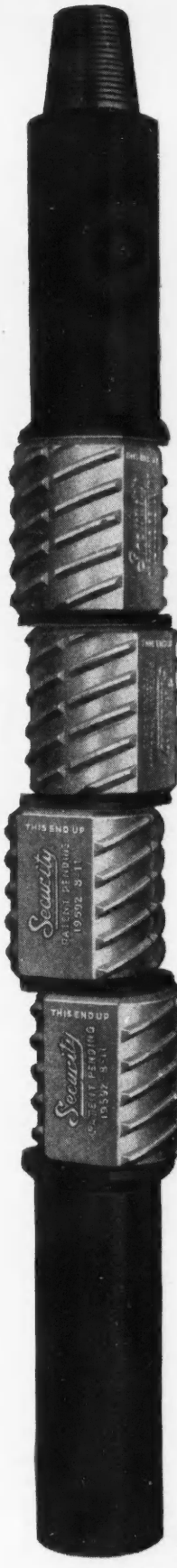
Oil Drilling Compounds

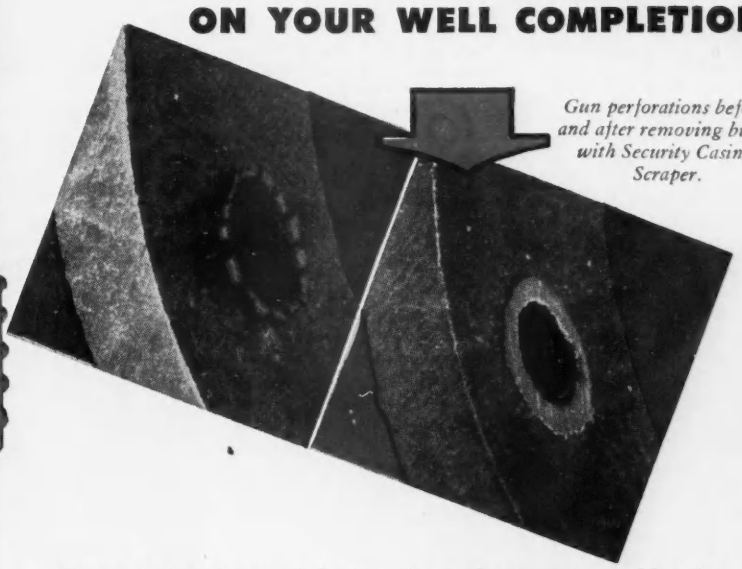
MEMPHIS 2, TENN.

"a Sulco Product"

No Rotation required

WHEN YOU USE A *Security* CASING SCRAPER ON YOUR WELL COMPLETION PROGRAM





Gun perforations before and after removing burrs with Security Casing Scraper.

The exclusive design of the Security Casing Scraper enables the tool to be operated with an up and down movement, eliminating the necessity of moving in expensive rotary equipment. Because the cutters contact the full inside of the pipe, casing can be cleaned without rotation. Regular well pulling or servicing equipment can be used with the scraper operated on wire line, tubing or drill pipe.

THE SECURITY CASING SCRAPER quickly and thoroughly removes all obstructions, perforating burrs, and foreign matter from within the casing walls. This assures you of a free downward passage of all tools, and a positive seal on such equipment as washers, packers, and swabs.

The use of a Security Casing Scraper before the well is completed assures clean surfaces for immediate and future production operations.

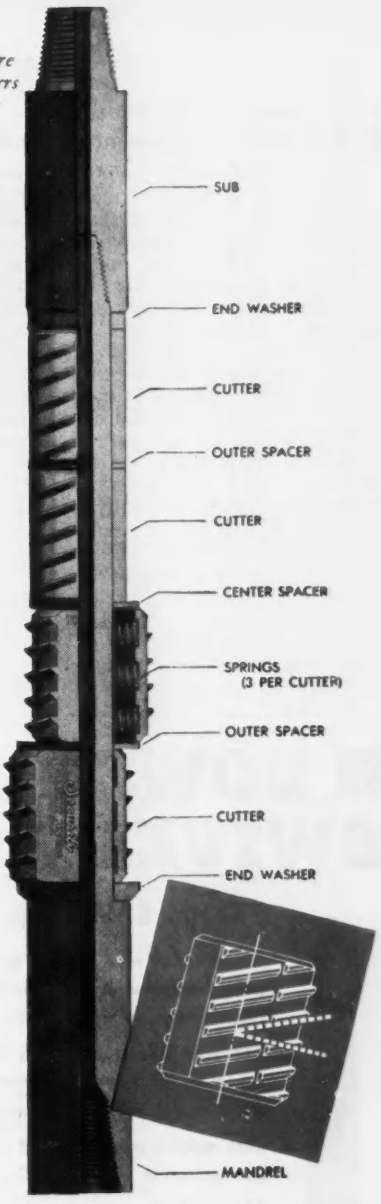
The Security Casing Scraper shears clean instead of crushing or scraping the casing walls. Positive shearing action is provided by 360° contact of the casing circumference at all times with 24 shear teeth having 98 linear inches of cutting surface, acting upon each point in the casing wall 800 times. This positive shearing action results in clean removal of burred gun perforations and all foreign matter leaving a full unrestricted opening.

FEW PARTS—SIMPLE CONSTRUCTION—ASSURE ECONOMY

Four reversible cutters having rectangular openings through the center are slidably mounted on a square mandrel. These cutters are firmly expanded against the casing walls by strong coil springs and are reversible, providing new sharp teeth when required.

Write today for our free bulletin CS-463 which describes the Security Casing Scraper in detail.

A Rock Bit or Blade Type Bull Nose can be used on the bottom connection.



Helical teeth produce shearing action, which quickly and cleanly cuts away all foreign materials and undesirable protrusions.

Security
DRILLING AND PRODUCTION EQUIPMENT

SECURITY ENGINEERING CO., INC.
ONE OF THE DRESSER INDUSTRIES
MAIN OFFICE AND PLANTS: WHITTIER, CALIFORNIA
EXPORT OFFICE: SUITE 800, CHANIN BUILDING, 122 EAST 42ND STREET, NEW YORK 17, NEW YORK
BRANCHES IN ALL PRINCIPAL OIL FIELDS

NEW CEMENTING UNITS—Spartan equipment en route to a well. New air bulker in rear.

New Operating Principle Used By Spartan Bulk Cementing Units

An entirely new principle is included in the fleet of bulk cement units being put into operation by Spartan Tool and Service Company. Twelve of these units have arrived and are operating in the field. The balance of the initial fleet of 75 units will be placed in the field as soon as possible.

The new principle of operation involves the use of air to empty the bulk cement trucks instead of mechanical conveyors. It takes only 1½ pounds per square inch of air pressure to unload the bulk units efficiently. By regulating the amount of air there is ample flexibility in feeding cement at any rate from a mere trickle to far beyond the capacity of any cement mixer.

Tests have been made at the Spartan plant in Houston and at actual cementing jobs and no new problems have been caused by this method. The test showed that water-cement ratios and slurry weights adequately cover the effective range for oil well cementing purposes.

The air can be connected from one bulk unit to another in an emergency by means of a hose. Also there will be an additional air pump on the tractors which haul the bulk units. By having more than one source of air supply, there will be a great factor of safety against shutdowns.

On January 8 Spartan announced that its first oil well cementing unit was completed at the Houston plant and did the first cementing job on a well at Victoria, Texas. Since then it completed 14 jobs in the first 18 days. This unit is power-operated. Meanwhile, the first steam unit and another power unit were completed and sent to the field.

While additional units are being assembled in the original building at the Spartan plant, plans are going ahead for the erection of two large shop buildings so that a production line can be established to turn out these tried and proved units on a production schedule so that the initial fleet of 50 cementing units can be completed as quickly as possible.

Dowell Opens District Office At New Orleans and Names Manager

Dowell Incorporated, through General Sales Manager R. D. Shaw, announce the formal opening of its New Orleans district, which includes South Louisiana, all of Mississippi, Alabama, and western Florida and is the headquarters for all of the company's operations, both Oil Field and Industrial divisions, in this area.

L. B. Swan

L. B. Swan has been appointed manager and is now residing in New Orleans. Swan has been with Dowell since 1940 and for the past four years has been at the company's general office in Tulsa, serving as development engineer for the Oil Field division. Swan is a petroleum engineer, graduate of the University of Tulsa, and a member of AIME. His background includes four years in the Production Engineering department of Stanolind Oil & Gas Company.

District office manager at New Orleans is R. L. Dickson. Dickson began work with Dowell in 1941 and, except for his period of service with the armed forces during the war, has been located at Tulsa.

The new district includes the Dowell station at Lafayette, La., with C. L. Power, Jr., as development engineer and J. O. Hendrick as station manager; the station at Hattiesburg, Miss., with Z. V. Morgan as station manager; the Baton Rouge, La., industrial area with L. G. Hargett as development engineer. Plans include a future station at Houma, La.

Wilson Welder Officials Named

Thomas B. Hasler, formerly president of Wilson Welder & Metals Company, Inc., subsidiary of Air Reduction Company, Inc., was elected chairman of the board of directors succeeding C. E. Adams, who resigned as chairman and director F. B. Adams, Jr., was elected president and a director.

BOWEN REMOVABLE SWIVEL ROPE SOCKETS

Split Liner Type

FOR SWABBING AND BAILING

These handy rope sockets prevent a fire hazard as they can be babbitted away from a well. They can be removed from the line without cutting the line or melting the babbitt.

The split liner type allows the babbitted line to pass through the Inner Assembly of Bowen Automatic Line Wipers and the solid liner in the other model will pass through the crown blocks.

Both models may be fitted for ½", 9/16" or ⅝" line and are 1⅝" O.D. Connection is 1-1/16" O.D., A.P.I. Sucker Rod Pin.

Also made in other popular sizes.

Complete instructions are furnished with each socket. Catalog with detailed information will be furnished promptly when requested.

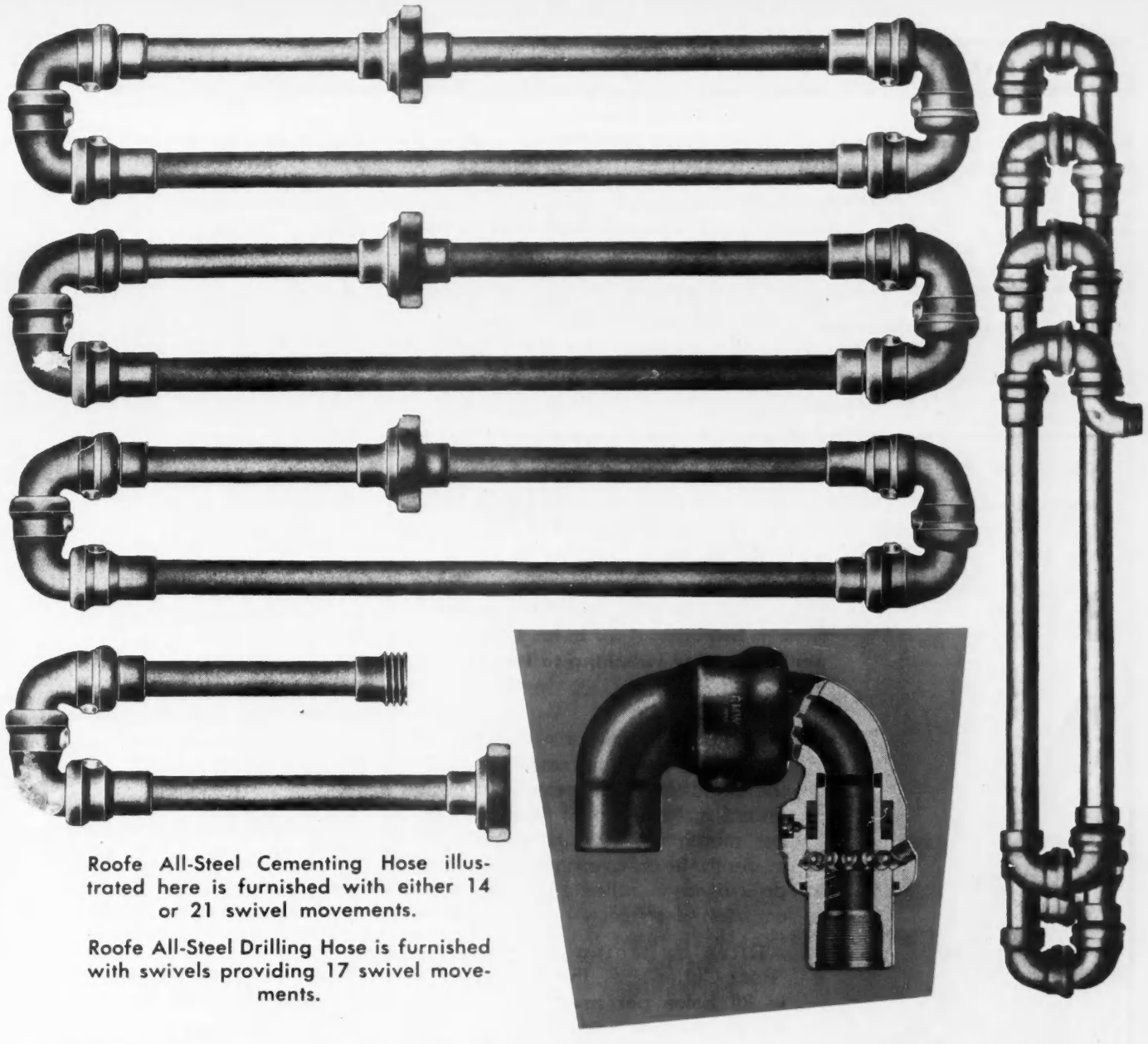
See Bowen Co. of Texas Section 1948 Composite Catalog.

Through Supply Stores anywhere in the U.S.A.

BOWEN CO. of TEXAS, INC.

Office: 2429 Crockett St., P. O. Box 1025, HOUSTON 1, TEXAS, Phone C-9457
Odessa, Texas, Phone 789—Midland, Texas, Phone 1439

Solid Liner Type



Roofe All-Steel Cementing Hose illustrated here is furnished with either 14 or 21 swivel movements.

Roofe All-Steel Drilling Hose is furnished with swivels providing 17 swivel movements.

Roofe All-Steel Drilling Hose and Cementing Hose are available for 5,000 lb. and 10,000 lb. pressures

Whichever meets your needs . . . for medium or high pressure service . . . you will find that Roofe All-Steel Cementing and All-Steel Rotary Hose is the most dependable, the easiest swiveling hose available.

The exclusive bearing and packing construction in Roofe Swivel Joints is designed so that cement, mud, caustic mud additives and other abrasives can not reach the bearings. This means longer joint . . . and hose life . . . with less maintenance, less lost time. Specify Roofe Swivel Joints. They are available now.

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HUNT TOOL COMPANY

NOW MANUFACTURED AND DISTRIBUTED BY

TOOL COMPANY

HOUSTON, TEXAS

FIELD SHOPS: Houston, Bay City, Corpus Christi, Jennings, Harvey
EXPORT SALES: Hunt Export Company, 19 Rector St. New York; Adva. Pte. R. Saenz Pena 832, Buenos Aires; Port of Spain, Trinidad; Mexico City, D.F.

A BUSINESS BUILT ON *Good* SERVICE

Industrial Sales Official Named For Westinghouse Electric Firm

F. D. Weatherholt was named assistant industrial sales manager for Westinghouse Electric Corporation with headquarters at East Pittsburgh.

A native of Cloverport, Ky., Weatherholt joined Westinghouse in 1921 as a member of the Graduate Student Course and upon completion of the course was assigned to small motor sales in East Springfield, Mass. In 1925 he was transferred to the Albany, N. Y., sales office and a year later was assigned to the New York City office. In 1940 he was named Eastern resale manager, the position he held at the time of his new appointment.

Kropp Forge Official Selected For Outstanding Young Man Award

Raymond T. O'Keefe, Jr., vice president in charge of labor relations, Kropp Forge Company, Chicago, has been named "Outstanding Young Man of 1947" by both the Chicago Junior Association of Commerce and Industry and the Illinois Junior Association of Commerce.

PROOF OF BIT EFFICIENCY . . .

(No. 1 of a series)

33 1/3% More Holes Per Month!

Major Seismograph operator's record* reveals increase of 20 holes per month per drill, after switching to Hawthorne "Rock Cutter" Bits.

Patent Pending

Hawthorne Replaceable Blade Bit with "Rock Cutter" Blades. Blades are easily and quickly replaced on drill, with tools commonly available. Stabilizer and Reamer, shown between Adapter Sub and Locking Bowl, is optional equipment for use in extremely hard formations.

Drilling in formations consisting of about 50% limestone and 50% sticky shale and clay, this operator formerly drilled an average of 60 shot holes per month per drill, averaging 70' in depth. In an average month each drill used 5 roller bits and **sixty** common drag bits.

After switching to Hawthorne "Rock Cutter" Bits, **this average rose to 80 holes per month** . . . same depth . . . same formations . . . same drills . . . same drillers. Each drill now uses **two** roller bits and **only twelve sets of new Hawthorne Blades** each month. Bit savings alone average $321.60 per month per drill!

Because he's using Hawthorne "Rock Cutter" Bits, this operator is now getting **maximum footage** from his drills. Profit from his experience . . . switch to Hawthorne Bits **now.** They're available in all popular sizes and can be delivered without delay. Full information will be furnished upon request.

***Based on six month's continuous operation, using two drills.**

Herb J. Hawthorne

P. O. Box 7299 **5003 North Shepherd**

HOUSTON 8, TEXAS

Market Development Unit Created By U. S. Steel Corporation

A market development division has been created as a new unit of the sales department of U. S. Steel Corporation of Delaware, it was announced by David F. Austin, vice president for sales.

R. J. Ritchey

R. J. Ritchey, manager of market development of Carnegie-Illinois Steel Corporation, U. S. Steel subsidiary, has been appointed director of the new division.

Ritchey, who attended the University of Pittsburgh and Temple University, began his service with Carnegie-Illinois in 1937 in the sales promotion division of the sales department. He was made assistant manager of the company's market development division in 1942, and manager in 1945.

Lane-Wells to Use Stanolind's Bottom-Hole Gas Well Flowmeter

Through contract agreement, Stanolind Oil & Gas Company has granted The Lane-Wells Company the use of its recently developed bottom-hole gas well flowmeter.

The instrument, contained in a tube 2¼ inches in diameter by seven feet long, is lowered down the tubing of gas wells with an ordinary piano-wire depth measuring line, and records production from each gas sand while the well is flowing, it being neither necessary nor desirable to kill the well in order to make productivity tests. The instrument may also be used on gas injection wells.

This gas well flowmeter has been successfully used in more than 175 wells in the Hugoton gas field of southwestern Kansas, where it has proven of great value in planning well workovers, in indicating the necessity of acidizing, and in checking on the results of acidizing and workovers. It has, in effect, added a large amount of gas reserves to the field, since portions of gas sands previously considered non-productive in particular parts of the field have been shown to contain large quantities of gas, and consequently have been produced by additional well completions. Conversely, in certain parts of the field, other sands previously considered productive have been shown to be producing only a small percentage of the total gas from the well; and many unprofitable workover jobs have thus been avoided.

The instrument, developed in the Production Research Section of the Stanolind Research department at Tulsa, consists essentially of a detecting element, a recording chart, and a small motor, powered by flashlight batteries, which operates the recording mechanism. The detecting element is a hot wire anemometer connected in a Wheatstone bridge circuit to measure the resistance change of the hot wire as it is cooled by flowing fluids.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

B. L. Potter

J. W. Reed

Three Vice Presidents Appointed By Cooper-Bessemer Corporation

The Cooper-Bessemer Corporation has elevated three sales executives to positions of vice president. They are J. W. Reed, the Atlantic Coast manager of the Gas Engine and Compressor division; A. A. Burrell, Southwestern district manager, with headquarters at Dallas; and B. L. Potter, Mid-Continent manager with headquarters at Tulsa.

A. A. Burrell

Reed, a Cooper-Bessemer veteran of 25 years service, served the company as Pacific Coast manager from 1925 to 1940 when he assumed his present position in New York.

Burrell joined Cooper-Bessemer in 1925 when it was the C. & G. Cooper Company and has been Southwestern district manager since that time.

Potter will soon complete his 35th year in the engine-building industry. He joined the Bessemer Gas Engine Company in 1913 and was in charge of its Mid-Continent area in 1929 when the company merged with the C. & G. Cooper Company to become Cooper-Bessemer. Since that time, Potter has occupied the position of branch manager of the Tulsa office.

Peter F. Hurst, Vice President, Becomes President of Aeroquip

Peter F. Hurst has been elected president of Aeroquip Corporation, Jackson, Mich. Hurst was instrumental in the organization of Aeroquip Corporation in 1940, and was previously its executive vice president and general manager.

Aeroquip Corporation manufactures flexible hose lines, fittings and hydraulic accessories.

Allis-Chalmers Vice Presidents Elected to Board of Directors

W. A. Roberts and W. C. Johnson, executive vice-presidents of Allis-Chalmers Manufacturing Company were elected to the board of directors.

Roberts is executive vice president in charge of the tractor division, while Johnson is executive vice president for the general machinery division.

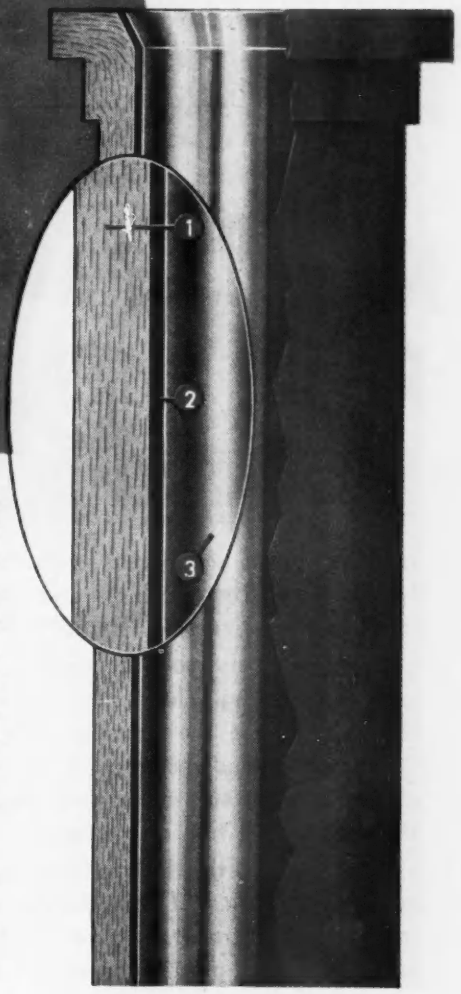
Here's why

FALCON

SLUSH PUMP LINERS

LAST LONGER!

— an achievement in metallurgy



Under the most abrasive mud conditions and highest pressures encountered in drilling, Falcon Liners are turning in record-breaking performances and long service life in the oil fields all over the world. This is no accident. It is the result of combining proper materials with sound engineering know-how.

1 CHROMIUM - MOLYBDENUM ALLOY STEEL is made into an integral forging, resulting in a fine, uniform grain structure which increases carburizing effectiveness and greatly facilitates uniformity of hardness. Also makes for a strong, tough core.

2 EXTREME HARDNESS 62-65 Rockwell "C" (approximately 700 Brinell) with a depth of penetration of .090" - .120", depending on wall thickness of liner. Careful control of hardness by heat samples and rigid inspection results in minimum distortion. Therefore, no heavy grinding into hardened surface is required to obtain a smooth straight bore, which by the Falcon process, is achieved by honing for both dimension and finish.

3 SUPER HARD MIRROR FINISH. A highly polished micro-finish which can only be produced by honing assures longer liner life against abrasion and high pressures.

Sold only through leading supply houses everywhere

FALCON PRODUCTS, INC.

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LOS ANGELES, CALIF. 405 Subway Terminal Building • HOUSTON, TEXAS 1802 Maury Street

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Export Representative: Guy E. Daniels, 30 Rockefeller Plaza, New York 20, N. Y.

NEW Books

Industry Progress

The anniversary volume "Seventy-Five Years of Progress in the Mineral Industry," has several papers of interest to those in the petroleum industry.

In the section devoted to Seventy-Five Years of Progress appears an article by Everette Lee DeGolyer entitled: "Seventy-Five Years of Progress in Petroleum." In the section on Proceedings of the 75th Anniversary Celebration and World Conference on Mineral Resources, which was held in New York in March, 1947, are several papers on petroleum which were presented at the meeting. These are Iron Ore and the Steel Industry, by Charles M. White; International Aspects of the Petroleum Industry, by Sir William Fraser; World Coal Resources, by C. Augustus Carlow; Petroleum and Natural Gas; Uses and Possible Replacements, by Robert E. Wilson and J. K. Roberts; and Techniques of Mineral Exploitation of the Future, by Louis S. Cates and Howland Bancroft.

The book includes tables, charts, and maps and a complete index. Copies may be obtained from The American Institute of Mining and Metallurgical Engineers, New York.

PAW History

"A History of the Petroleum Administration for War, 1941-1945," prepared under the direction and editorship of John W. Frey and H. Chandler Ide, is a report of the activities of PAW. It is not only a report of the committee but the history of a unique experience of government-industry cooperation.

A fitting quotation from General Brehon Somervell, Major General Edward M. Powers, Admiral F. J. Horne and Rear Admiral John H. Cassady of the Joint Chiefs of Staff, Army-Navy Petroleum Board at the close of the war in joint statement follows: ". . . at no time did the Services lack for oil in the proper quantities, in the proper kinds and at the proper places. Because of the resourcefulness, untiring and unceasing efforts, and outstanding accomplishments of the Petroleum Administration for War and the petroleum industry, not a single operation was delayed or impeded because of a lack of petroleum products. No government agency and no branch of American industry achieved a prouder war record."

This book includes only those activities of PAW which best show its general policies, patterns and trends. The book is well illustrated with many colored charts, tables, maps and photographs. Some of the topics covered in full-length chapters are The Story of Partnership, Development and Character of Government Organization; Mobilization of the Petroleum Industry; Wartime Petroleum Supply and Transportation; Wartime Petroleum Distribution and Marketing; Manpower; The Oil Industry Competes for Materials; The Story of Production, Miracles from Molecules, Natural Gas and Natural Gasoline, Foreign Petroleum Operations in Wartime; and Foreign Relations and Oil Policy.

Available from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price $3.

Oil Facts and Figures

The API has issued the eighth edition of "Petroleum Facts and Figures." This is the first edition that has appeared since 1941 and includes the War Period.

The edition includes authoritative information about the petroleum industry that can be reduced to statistical form. Every effort has been put forth to make it the most complete work of its kind. There are seven main divisions in the new volume: utilization, production, refining, transportation, marketing, general information and world statistics. There are 236 pages of tables and charts which are completely indexed.

Available from Department of Information, American Petroleum Institute, 50 West 50th Street, New York 20.

No More PARAFFIN ACCUMULATION

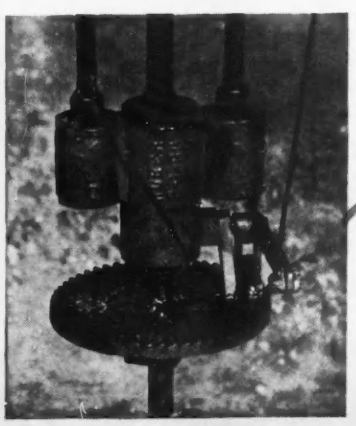
HUBER

PARAFFIN SCRAPERS

Imagine what you could save by eliminating the frequent and costly job of steaming out or "passing rods" to free your well of paraffin.

Huber Scrapers make a paraffin scraper out of your sucker rod string. These steel blades, shrink-welded to the rods, scrape the paraffin from the tubing as the string rotates and reciprocates. With the string rotated a fraction of a turn on each stroke, the scrapers keep the tubing wall free of any paraffin.

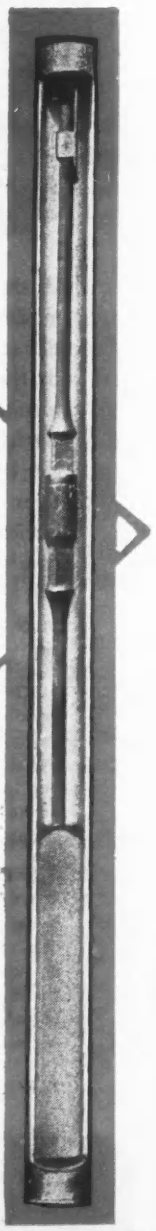
Operation of the Huber Scrapers is automatic and entirely mechanical. They require no service or attention. Install Huber Scrapers in your paraffin wells and eliminate the cost of paraffin removal.



AUTOMATIC ROD ROTATION

This rotating rod hanger is attached to the unit's or jack's head by conventional wire line bridle. Two ratchet levers engage the turntable, and by means of a flexible steel cable from the ratchet arm to the walking beam, the rods are rotated a fraction of a turn with every stroke of the pump.

ORDER FROM YOUR SUPPLY STORE



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PARAFFIN SCRAPERS

J. M. HUBER CORPORATION

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CLASSIFIED ADS

SERVICES · PERSONNEL · USED EQUIPMENT

Rates: Regular Classified (undisplayed) set in this size type: 10 cents per word. If Box Number is to be used count an additional six words. Replies forwarded without charge. Situation Wanted: 5 cents per word. Display advertisements, set in suitably larger type with ruled border: $9.00 per column inch per insertion. Situation Wanted: $4.50 per column inch. **All classified ads payable in advance.** 10% Discount if 3 or more insertions are ordered at one time. **COPY DEADLINE:** 10th of month preceding date of issue. Send copy and checks to: Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.

LEASES, DRILLING, ACREAGE, ETC.

■ SEE A. L. BOWLES, ADA, OKLAHOMA, FOR SHALLOW DRILLING DEALS IN OKLAHOMA.

FOR SALE

■ 2-E.L.I.-M5 shot hole drills. 1 mounted on 4 x 4 Chev. army truck with new motor, new tires. 4 x 4 Chev. water truck with 600 gal. tank, new tires. Drill in perfect condition, 16 mo. old; 1 mounted on 1942 Ford new 100 HP motor, new tires 1942 Ford water truck with 600 gal. tank. Good tires. All in good condition. Present operations Ada, Oklahoma. Will trade for Failing 1500 truck mounted. Write Charles L. Farris, P. O. Box 195, Ada, Oklahoma.

■ 1—15,000 Foot Power Rig Complete, Bethlehem MC-950 Drawworks with 4-383 HP 6 G-510 Superior Gas Butane Drilling Engines; 2 Pumps; 1—12,000 Foot Power Rig Complete w/Bethlehem MC-650 Drawworks with 3-LRO Waukesha Engines; 2 Pumps; 1—12,000 Foot Steam Rig Complete w/14x14 Ideal Ajax Engine; #12 Beaumont Iron Works Drawworks; 3—20" Pumps; 4—Boilers.
625 Fort Worth Club Bldg. Telephone 2-6269. Fort Worth 2, Texas

22W BUCYRUS SPUDDER

Mounted on 1½ ton Dodge truck driven 2100 miles. Spudder drilled less 3000 ft. All necessary tools for shot hole work. This equipment like new, ready to go. P. O. Box 1301, Midland, Texas.

WANTED TO BUY

We Will Buy Used Pipe of Any Description Anywhere in U.S.A.

FRIEDMAN IRON & SUPPLY CO.
P. O. Box 3095, Queensboro Station
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SHREVEPORT, LA.

OIL AND GAS SEPARATORS—good used 125 lb., 500 lb. and 1000 lb. complete, up-to-date.

STEEL TANKS—210 Barrel Welded; 250, 500 and 1000 Barrel A.P.I. Bolted. Address: Box 36W, c/o World Oil, Houston, Texas.

STOCKS, ROYALTIES

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Quotations Cheerfully Supplied
Inquiries Invited
JOHN J. O'KANE JR. & CO.
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42 Broadway, New York 4, N. Y.

SITUATION WANTED

■ Young MUD ENGINEER now in South America with major company desires position in Southwest. Available about April First. Now engaged in general petroleum engineering work. Considerable experience in drilling operations. Four years Texas A. & M. References furnished. Address: Box 39W, c/o World Oil, Houston, Texas.

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United Geophysical Company, Inc.

has openings in both North and South America for EXPERIENCED GRAVITY and SEISMIC PARTY CHIEFS, SEISMOLOGISTS, COMPUTERS, OBSERVERS SURVEYORS

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Petroleum Engineer

An oilfield service organization has opening for petroleum engineer in technical oil field service. Applicant must have some experience in oil production and degree in petroleum engineering. Permanent position with long established company. Write giving full details on education, experience, age and marital status. Attach small photograph. Address Box 38W, c/o World Oil, Houston, Texas.

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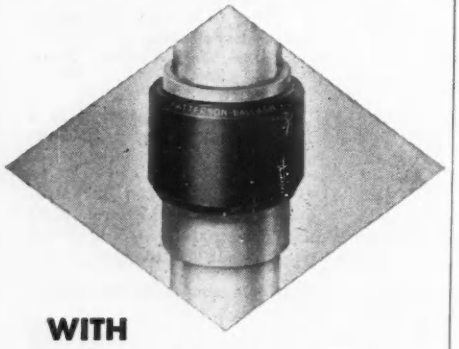

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SQUEAKS from the BULLWHEEL

The Better Life

"Do you still wake up with a grouch?"
"No, I got a divorce."

Life Is Like This

"Landlord, those people in the apartment above me won't give me a minute's peace. At 2 o'clock this morning they were jumping on the floor and making a terrible noise."
"Keeping you awake, eh?"
"No. I hadn't gone to bed."
"Working late?"
"Well, in a way. I was practicing on my saxophone."

Second Whack

"Come quick, Doctor! My wife has appendicitis."
"Impossible. I took out your wife's appendix a year ago and I never heard of anyone having a second appendix."
"Yeah, but haven't you heard of someone having a second wife?"

Close Squeak

"Johnny, what is a comet?"
Johnny looked blank.
"What is a star with a tail?" teacher prompted.
"Mickey Mouse!"

Poet's Nook

Lift your glass and make a toast
To lovely, frivolous Fran;
'Cause she's always a believer in
The law of supplyin' de man!

Encore

"My leg's a pretty stockingfull,"
Said Tessie with a laugh.
And we'll agree that that's no bull—
It's just a little calf.

Encore Some More

A good girl always sticks to "No!"
A bad girl always yesses;
A smart girl makes 'em sound alike
And holds 'em all on guesses.

Reaction Unknown

"Are you entertaining a man in your room?" asked the house detective over the telephone.
"Just a minute. I'll ask him."

They'll Get Over It

He had been overseas four years.
His wife—beautiful, blonde, luscious—met him at the dock.
They went to a hotel.
It was cozy.
There came a terrific knock at the door.
He leaped up. "Your husband!"
"Silly boy! He's thousands of miles away."

Memory Lane

70-year-old: "When I die I'd like to do it in a car crash at 80 miles an hour."
80-year-old: "I'd like to meet my finish in a plane doing 400."
90-year-old: "I'd like to be shot by a jealous husband."

This Curious World

Many a man with both feet on the ground takes orders from a man with both feet on the desk.

About the time you learn to make the most of life, most of it is gone.

A rude and vulgar man is one who stares at a girl's figure when she's doing her best to show as much of it as she can without getting arrested.

Said the bride: "Dissipation? But, Doctor, that's impossible! Why, he's been home every evening since we were married a month ago!"

Women and money are just alike. If you don't keep them busy they lose interest.

Shot—that which, if some people have more than one of, they're half.

An old maid is a girl who has made a miss of things.

Most girls attain their ends through lack of exercise.

Familiarity breeds attempt.

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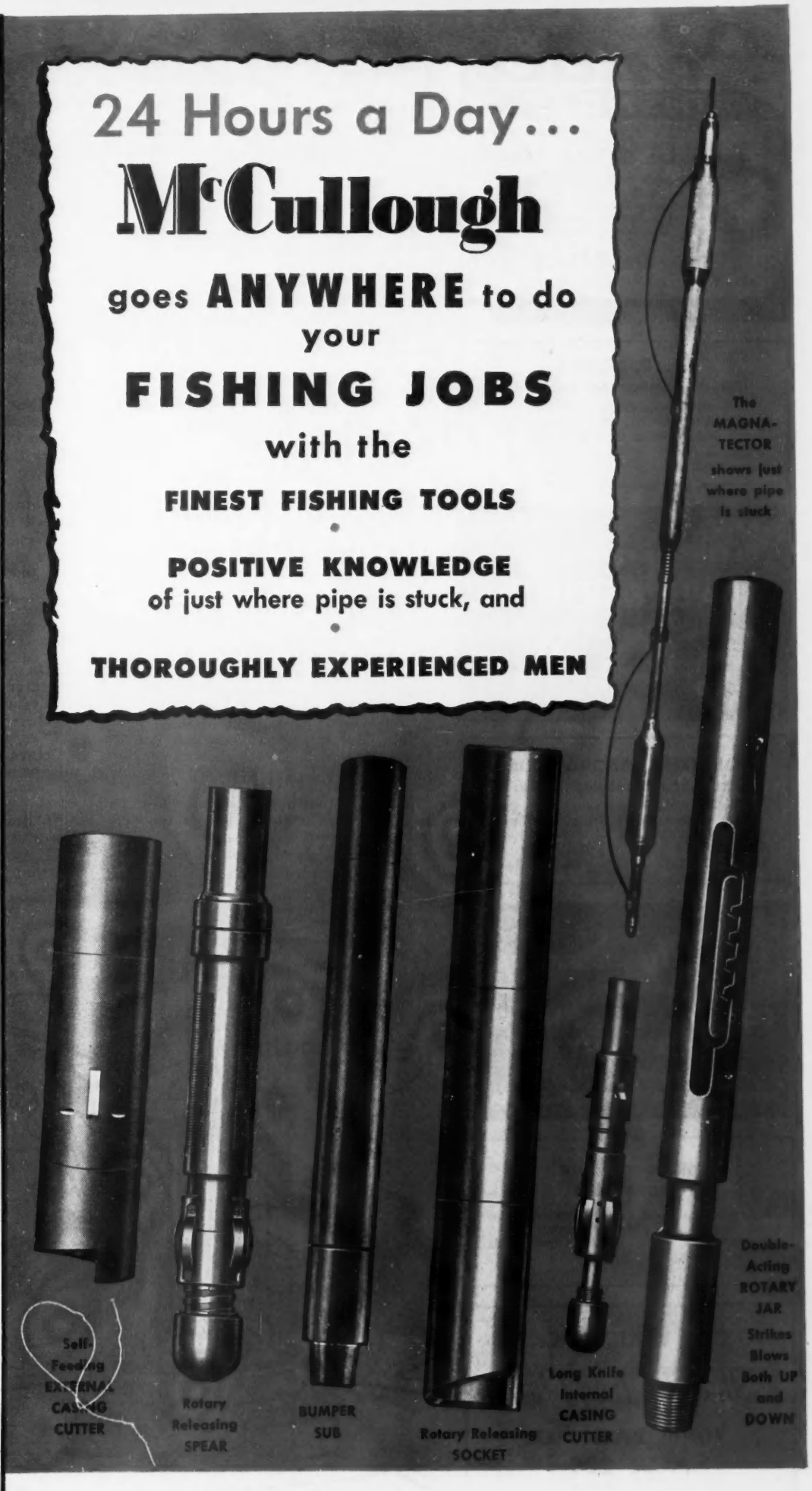
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DID YOU CHECK
The Trading Post
TURN BACK TO PAGE 289

SQUEAKS from the BULLWHEEL

Hints for Householders

Husband: "I'll bet if you were to give the landlord a kiss or two, he'd stop asking for the rent."
Wife: "No dear—that doesn't work."

Follow the Leader

"Won't you join me in a cup of coffee?"
"Sure. You get in first."

Breaking a Precedent

An artist kissed his model. "I bet you do that to all your models," she said.
"Nope. You're the first."
"I don't believe it. How many models have you had?"
"Four. A rose, an onion, a banana and you."

Hard to Down, This

"What is the name for an Indian speakeasy?"
"A swigwam."

Fine Treatment

"Doctor, I just dropped in to tell you how much I've benefited from your treatments."
"But you're no patient of mine."
"No. But my uncle was, and I'm his heir."

Careless Fellow

"Seaman Smith swallowed his knife, sir, and we've operated for its recovery without success."
"Very well. Issue Seaman Smith another knife."

Shady Limbs

"There are lots of boys and girls who don't neck in parked cars."
"Yeah. The woods are just full of them."

It Seems There were Seams

"I want to get a corset for my wife."
"What bust?"
"Nothing. It just wore out."

Dirty Trick

"How do you keep your children out of the cookie jar?"
"Lock the pantry and hide the key under the soap in the bathroom."

He Took the Cure

"I don't see John nearly as much as I used to."
"Well, you should have married him when you had the chance."
"I did."

Near Miss

"Does your girl smoke?"
"Not quite."

Hidden Asset

"Do you think you could support my daughter if you married her?"
"Yes sir."
"Have you ever seen her eat?"
"Yes, sir."
"Have you ever seen her eat when no one was watching?"

When Ladies Meet

"I don't intend to be married until I'm 30."
"I don't intend to be 30 until I'm married."